ANNE ARUNDEL COUNTY, MARYLAND
DEPARTMENT OF PUBLIC WORKS

BROAD CREEK II WATER TREATMENT PLANT EXPANSION

Project Number W804000
Contract Number W804001

PROJECT MANUAL

Bureau of Engineering
April 2012
# ANNE ARUNDEL COUNTY

## Broad Creek II WTP Expansion

**Project No.: W804000**  
**Contract No.: W804001**

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</tr>
</tbody>
</table>

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NOTICE TO CONTRACTORS
Bid No.: W804001
Project No.: W804000

Sealed bids, addressed to Anne Arundel County, Bid No. W804001, for BROAD CREEK II WATER TREATMENT PLANT EXPANSION for the Department of Public Works will be received until 1:30 P.M. local time, Tuesday, August 14, 2012, at the Office of the Purchasing Agent, 3rd Floor, Heritage Office Complex, 2660 Riva Road, Annapolis, Maryland 21401, after which they will be publicly opened and read in the Patuxent Conference Room, located on the same floor.

The Work includes the following major items: Expansion of the Broad Creek II Water Treatment Plant (WTP), Harry S Truman Parkway, Anne Arundel County, Maryland. Major new processes and equipment include two cascade aerators, one SuperPulsator clarifier, four Greenleaf filters, three clearwell pumps, one vertical paddle-wheel flocculator, one residuals clarifier mechanism, one submersible mixer, two factory-built aboveground suction-lift pump stations, three polymer feed units, lime feed equipment, and one sodium hypochlorite storage tank.

To all contractors, Anne Arundel County Purchasing Office now has bid results for Capital Construction Projects as well as Notice to Contractors on the Web Page. Entering http://www.aacounty.org/CentServ/Purchasing/index.cfm can access it.

On or after July 9, 2012, Plans and Specifications may be downloaded from the Anne Arundel County Purchasing website listed above. Plans will only be distributed via the web site.

This Contract will be constructed under the provisions of the Anne Arundel County Government July 1, 2006 "Standard Details and Specifications for Construction and Design Manual" and any subsequent revisions thereto.

The cost range for the Project is: above $3,000,000.

EQUAL OPPORTUNITY

It is the policy of Anne Arundel County, Maryland, to ensure equal employment opportunity for all persons, and to ensure that minority and women-owned business enterprises have the maximum opportunity to participate in the performance of all county contracts for supplies and services.

NON-DISCRIMINATION IN EMPLOYMENT

THE CONTRACTOR OR ANY SUBCONTRACTOR MAY NOT DISCRIMINATE IN ITS EMPLOYMENT PRACTICES AGAINST ANY EMPLOYEE OR APPLICANT FOR EMPLOYMENT BECAUSE OF RACE, COLOR, RELIGION, SEX, NATIONAL ORIGIN, ANCESTRY, HANDICAP, AGE OR MARITAL STATUS.

On July 19, 2012 at 2:00 P.M. local time, a Pre-Bid conference will be held at the Department of Public Works, Heritage Office Complex, 2662 Riva Road, Annapolis, MD 21401. ALL VISITORS are asked to check in with the second floor receptionist for meeting location. The intent of this conference is to clarify the Plans and Specifications advertised and intended for bidding purposes. All potential bidders are requested to attend this conference. However, attendance is not a requirement of the Contract.

Questions regarding this Project should be directed to the Project Manager, Vahid Tayebi at 410-222-7537.

ANNE ARUNDEL COUNTY
William L. Schull, C.P.M., CPPB
Purchasing Agent

A1-1
INFORMATION TO BIDDERS

Sealed bids in duplicate, addressed to the Purchasing Agent, Anne Arundel County, Maryland, for construction of the **Broad Creek II Water Treatment Plant Expansion**, as shown on drawings on file in the Office of the Department of Public Works, Heritage Office Complex, 2662 Riva Road, Annapolis, Maryland 21401 will be received in the Office of the Purchasing Agent, 3rd Floor, Heritage Office Complex, 2660 Riva Road, Annapolis, Maryland 21401, until ____________ at 1:30 p.m. Bids will be opened and read aloud in the Patuxent Room located on the same floor, immediately thereafter.

THE RIGHT IS HEREBY RESERVED TO REJECT ANY OR ALL BIDS AND TO WAIVE INFORMALITIES, AS THE INTERESTS OF THE COUNTY MAY REQUIRE.

All work to be performed under this Project shall be done under strict compliance with the Anne Arundel County Government July 1, 2006 "Standard Details and Specifications for Construction and Design Manual" and any subsequent revisions thereto. Copies of Standard Specifications for Construction and Standard Details may be obtained at the Department of Public Works, Heritage Office Complex, 2662 Riva Road, Annapolis, Maryland, 21401 and it shall be the duty of the Bidder to be familiar with these documents.

In addition, on May 18, 1990, the Commissioner of Labor and Industry adopted, through incorporation by reference to the Maryland Occupation Safety and Health Standards under COMAR 09.12.31 Maryland Occupational Safety and Health Act, amendments and revisions relating to Excavations as published in 54 Federal Register No. 209 (October 31, 1989) pages 45948-45991 and codified in Sub Part 29CFR 1926.650-1926.652 and Appendices A-F, together with certain amendments. The amendments are found at Maryland Register, Volume 17, issue 6 (Friday, March 23, 1990), pages 746-748. The Commissioner’s action is effective May 28, 1990. All holders of the Anne Arundel County Standard Specification and Details for Construction should familiarize themselves with these regulations and be guided accordingly.

Each bid must be enclosed in a sealed envelope marked “Proposal No. W804001 Anne Arundel County, Maryland.” Bids made other than on the attached forms will not be considered. Changes in the phraseology of the bid, additions, or limiting provisions will render the bid irregular and may cause its rejection.

All bids shall include the following forms, each of which is to be submitted in duplicate:

1. Anti-collusion and non-bribery affidavit
2. Proposal form
(3) Bid Bond (Bonding Companies must be licensed to do business in the State of Maryland and have complied with the law and the regulations of the U.S. Department of the Treasury and be approved as A Certified Companies or A Certified Reinsurer Companies.)

(4) List of subcontractors and Equipment Suppliers; and

(5) Sales tax affidavit

Failure to complete and submit these forms shall render the proposal irregular and may be cause for rejection of the bid.

The Proposal form shall include the price, in figures, for each item of the proposed work and must be signed on behalf of the bidder. The bidder must examine the drawings, standard specifications, standard details and contract specifications carefully, and should make a personal examination of the location and nature of the proposed work. In case doubt shall arise as to the meaning or intent of anything shown on the drawings or comprised in the Standard Specifications, Standard Details and Contract Specifications, inquiry should be made of the project engineer, of the Department of Public Works before the bid is submitted. Submission of the bid shall indicate that the bidder thoroughly understands the drawings and the terms of the specifications. Bidders are especially directed to fill out the “total Price” column and total their bids, so that the results of the bidding, barring possible arithmetical errors, will be at once known. Any errors in computation will be corrected by the engineer when the bids are canvassed. The County reserves the right to accept alternatives in any order, to award on any bid item or combination of bid items and to reject all bids if, in the sole determination of the County, it is advantageous to the County to do so. Any errors in computation or math will not invalidate the bid. In case of any discrepancy between the total figure and the correct total of the line items on the bid, the correct total of all line items shall govern and shall become the bid price.

Each bid must be accompanied by, and have sealed in the same envelope with the bid, a certified check or bid bond acceptable to the County for five percent (5%) of the amount of the bid, payable to Anne Arundel County, Maryland; and unless so accompanied, the bid will not be considered. The check or bid bond will be forfeited to the County as liquidated damages in case the contract, performance bond, and labor and materials bonds are not executed within ten (10) days after receiving the contract for execution.

The list of subcontractors and equipment suppliers to be submitted with the bid need only show certified small business, minority business and women business enterprises, which the bidder intends to use. In the event that the bidder cannot participate, the bidder shall include with the bid a notarized affidavit showing the evidence of the effort made to achieve this goal. Failure to submit the list of subcontractors and equipment suppliers delineating SBE, MBE, and WBE participation and/or the good faith documentation at the time the bid is submitted shall render the bid irregular and may be cause for rejection of the bid. The complete list of subcontractors and suppliers will be required from the apparent low bidder within (10) days of a request by the County.

The experience and equipment certification is to be submitted to the county by the apparent low bidder within ten (10) calendar days after request from the County.

Each bid must include a signed and notarized affidavit concerning sales and use tax. It is the bidder’s responsibility to contact the State of Maryland, Comptroller of the Treasury, Retail Sales Tax Division, to determine if any portion of the project is exempt from sales use tax.
THE APPARENT LOW BIDDER MAY NOT WITHDRAW ITS BID WITHIN NINETY (90) DAYS AFTER BID OPENING.

If the bidder, to whom an award is made, shall fail to execute the contract and bonds, the award may be annulled and the contract awarded to the second lowest responsible bidder, and such bidder shall fulfill every stipulation embraced herein, as if the bidder were the original party to whom the award was made; or the county may reject all of the bids, as its interests may require.

The County will hold the checks and/or bid bonds submitted by all bidders with their bids, until the execution and delivery of the contract and bonds whereupon they shall be returned.

As required by the Maryland Law, all foreign corporations doing business within the State of Maryland are required to be registered with the State Department of Assessments and Taxation as a condition precedent to the award of a contract.

If the contractor is a corporation, the contract shall be accompanied by a copy of the corporate resolution authorizing the officer of said corporation, whose name appears on the contract, to execute the contract. If a person other than an officer is designated, it must be stated under oath that the person is the agent of the corporation and is duly authorized to act for an in behalf of the corporation.

The Bidder must perform 51 percent (51%) of the work with his own forces.

Bidders are further reminded of State Finance and Procurement Article, Section 17-106 Annotated Code of Maryland, which provides:

Before a contractor receives a progress or final payment under a contract covered by payment security, the contractor shall certify, in writing that, in accordance with contractual agreements, suppliers, and subcontractors:

(1) Have been paid from the proceeds of previous progress payments; and

(2) Will be paid in a timely manner from the proceeds of the progress or final payment currently due.

The contractor shall make available, at anytime to the County, the contractor’s records for the purpose of auditing and/or verifying the contractor’s costs in connection with negotiated contracts, change order, or other amendments to the contract.
**Executive Order 24**

Pursuant to Executive Order 24, vendors are required to comply with all applicable laws and regulations relating to the employment of aliens. If a vendor fails to comply with applicable laws and regulations relating to employment of aliens, such failure shall constitute a material breach of the vendor’s contractual relationship with the County and shall be grounds for termination of the contractual relationship. By executing this Agreement, the Contractor certifies that it is aware of its obligations under Executive Order 24 and that it complies with all applicable laws and regulations relating to the employment of aliens. Contractor shall include this clause in all subcontracts, making subcontractors subject to these requirements.

**Non-Discrimination Clauses:**

Contractor shall comply with Executive Order 11246 entitled “Equal Employment Opportunity” as amended by Executive Order 11375, and as supplemented in U.S. Department of Labor Regulations 41 CFR Part 60.

The Contractor agrees not to discriminate in any manner against any employee or applicant for employment because of race, creed, color, or national origin; and, is obligated to include a similar requirement in all subcontracts, except subcontracts for standard commercial supplies or raw materials. In addition, the contractor and all subcontractors shall agree to post in conspicuous places, available to employees and applicants for employment, notices setting forth the provisions of the non-discrimination clause.

Where the Contractor willfully fails to comply with the non-discrimination provisions, the County may, where the Contract is still executory in part, compel continued performance of the Contract, but the County shall be liable only for the reasonable value of services performed and materials supplied from the date that the breach of contract was discovered, and any sums previously paid by the County under the Contract shall be set off against the sums to become due as the Contract is performed.

If any subcontractor willfully fails to comply with the non-discrimination provisions, the Contractor may void the subcontract and shall be liable only for the reasonable value of the services performed and materials supplied to the date of the voiding of the subcontract.

As to all contracts for materials, supplies, maintenance, services or other procurements except building construction services, the vendor agrees not to discriminate in any manner against any employee or applicant for employment because of race, creed, color, national origin, or sex. Any Contract with the County requiring subcontracts shall include similar requirements in each subcontract. The Contractor further agrees to comply with all applicable federal, state, and local laws and executive orders relating to equal employment opportunity.

**Equal Opportunity Clause:**

It is the policy of Anne Arundel County, Maryland, to ensure Equal Employment Opportunity for all persons, and to ensure that Minority and Women-Owned Business Enterprises have the maximum opportunity to participate in the performance of all County Contracts for supplies and services.
ANNE ARUNDEL COUNTY, MARYLAND

Solicitation Check List

Broad Creek II Water Treatment Plant Expansion
PROPOSAL NO.: W804001
Project No.: W804000

________________________________________________________________

THIS CHECKLIST IS PROVIDED FOR YOUR CONVENIENCE

_______  Bid Response/Proposal shall be delivered to the County Purchasing Department no later than the date and time shown in the Solicitation. Did you visit our website at (http://www.aacounty.org/CentServ/Purchasing/index.cfm) for any addenda, which may have been posted to our website or eMD Marketplace?

_______  Did an authorized company representative sign the Bid Response Form?

_______  Did an authorized company representative sign and notarize the Affidavit form(s)?

_______  Did you include the required signature authority documents, if required?

_______  If you are an entity (limited liability partnerships, corporations, limited partnerships, limited liability companies, limited liability limited partnerships, business trusts, real estate investment trust and trade name filings), is the legal name of your company listed with the State of Maryland Department of Assessments and Taxation and in good standing? You may check by going to www.sdat.org.

_______  If this Solicitation requires a Bid/Proposal bond, did you include one?

_______  Did you provide one original and one copy of your response?

_______  Is the outside of the submittal envelope marked with the Bid/Proposal Number, the title, the due date, your company name, and your company address?

MANDATORY REQUIREMENTS

The following item(s) are MANDATORY and shall be submitted, in fully executed format, with Bid Response/Proposal in order to be considered for an award. If the following item(s) are not submitted with the Bid Response/Proposal, the Bid/Response/Proposal shall be considered null and void, and therefore, will be rejected.

(A)  Bid Bond or Certified Check (5%)

(B)  County's Bid Response Form
NOTE: THIS FORM MUST BE SUBMITTED IN DUPLICATE WITH THE BID

ANNE ARUNDEL COUNTY

BROAD CREEK II WATER TREATMENT PLANT EXPANSION

Proposal No.: W804001
Project No.: W804000

AFFIDAVIT

On behalf of ___________________________________________, I do solemnly declare and affirm, under penalty of perjury, that to the best of my knowledge, information, and belief:

1. Neither ___________________________________________, nor any of its officers, directors, or partners, or any of its employees who are directly involved in obtaining or performing contracts with the State of Maryland, a unit of the State (as defined in '16-101 of the State Finance and Procurement Article), or a local governmental entity in the State, has:

   (a) been convicted of bribery, attempted bribery, or conspiracy to bribe, under the laws of any state or of the federal government;

   (b) been convicted under a State or federal law or statute of any offense enumerated in §16-203 of the State Finance and Procurement Article; or

   (c) been found civilly liable under a State or federal antitrust statute as provided in §16-203 of the State Finance and Procurement Article.

2. ____________________________________________ shall not knowingly enter into a contract with a public body under which a person or business debarred or suspended under Title 16, Subtitle 3 of the State Finance and Procurement Article will provide, directly or indirectly, supplies, services, architectural services, construction related services, leases of real property, or construction.

3. Neither ___________________________________________, nor any employee or representative of ____________________________________________:

   (a) agreed, conspired, connived, or colluded to produce a deceptive show of competition in the preparation of the bid or offer being submitted; or
NOTE: THIS FORM MUST BE SUBMITTED IN DUPLICATE WITH THE BID

(b) has in any manner, directly or indirectly, entered into any agreement, participated in any collusion to fix the price of the bid or proposal of any bidder or offeror or any competitor, or otherwise taken any action in restraint of free competitive bidding in connection with the contract for which the bid or offer is submitted.

Contractor: _______________________________________

By: _____________________________________________

Title: ___________________________________________

Date: ___________________________________________

Subscribed and sworn to before me, a Notary Public of the State of __________, County or City of ________________, this _________ day of __________________, ______.

__________________________________________
(Notary Public)

My Commission expires: ___________________________.
NOTE: THIS FORM MUST BE SUBMITTED IN DUPLICATE WITH THE BID

ANNE ARUNDEL COUNTY

Broad Creek II Water Treatment Plant Expansion
Proposal No.: W804001
Project No.: W804000

AFFIDAVIT CONCERNING SALES AND USE TAX

APPLICABLE TO THE CONSTRUCTION OF
WATER AND WASTEWATER TREATMENT FACILITIES

I DO SOLEMNLY DECLARE AND AFFIRM, under the penalties of perjury, the following:

1. That I am aware of the following:

   a. Water and wastewater treatment facilities consist of both real and tangible personal property.

   b. As a general rule, all of the inter-connected machinery and equipment for processing and treating water or wastewater at a treatment facility is considered tangible personal property. This would include, for example, all of the tanks, pumps, pipes, valves, electrical systems, and chemical handling equipment.

   c. Buildings and the systems serving the buildings, such as HVAC systems, plumbing and electrical service, as well as roadways, pavements, and fencing at treatment facilities are improvements to the realty. Off-site pipes and pumping equipment which transport water or wastewater to or from a treatment facility are normally real property improvements.

   d. However, if significant processing occurs at a wastewater pumping station, the equipment will be considered tangible personal property.

2. That I am further aware of the following:

   a. That a contractor who furnishes materials and is responsible for their
NOTE: THIS FORM MUST BE SUBMITTED IN DUPLICATE WITH THE BID

installation as real property is responsible for paying sales and use tax on the purchase of materials so installed.

b. That a contractor who furnishes and installs any machinery or equipment which remains tangible personal property may buy it tax-free by issuing a resale certificate to the vendor.

c. That the resale of the tangible personal property included in a water or wastewater treatment facility to a local government unit is exempt.

3. That in submitting a bid, the contractor has afforded Anne Arundel County, Maryland the benefit of any exemption.

4. That the contractor will refund to Anne Arundel County, Maryland any refund of sales or use tax received by the contractor as a result of the County's exemption.

____________________________________
Signature

____________________________________
Name and Title of Signer

____________________________________
Company

____________________________________
Date

SUBSCRIBED TO AND SWORN TO BEFORE ME, A Notary Public of the State of ____________, County or City of ________________ this year and date first above written.

____________________________________
Notary Public

____________________________________
My Commission Expires:
NOTE: THIS FORM MUST BE SUBMITTED IN DUPLICATE WITH THE BID

PROPOSAL

TO ANNE ARUNDEL COUNTY, MARYLAND

Broad Creek II Water Treatment Plant Expansion
Proposal No.: W804001
Project No.: W804000

Made this ______ day of ____________________________ , ___.

by__________________________________________________________

Business Address:______________________________________________

We/I the undersigned Bidder declare that the only person, firm, or corporation, or persons, firms, or corporations, that has or have any interest in this Proposal, or in the Contracts proposed to be taken, is or are the undersigned; that this Proposal is made without any connection or collusion with any other person, firm, or corporation making a Proposal for the same work; the undersigned further certifies that they have received Drawings, Specifications, Addenda (if any), and copy of this Proposal and that they constitute all instruments for bidding this contract, and that the Specifications, form of contract and the Drawings, therein referred to, have been carefully examined and are understood; that as careful an examination has been made of the worksite as is necessary to become informed as to the character and extent of the work required; and that is proposed and agreed, if the Proposal is accepted, to Contract with Anne Arundel County, Maryland, in the form of contract hereto attached, to do the required work in the manner set forth in the Specifications and as shown by the Drawings.

If this Proposal shall be accepted by Anne Arundel County, Maryland and the undersigned shall refuse or neglect, within ten (10) days after receiving the Contract for execution, to execute the same and to give the stipulated Bond, then said County may, at its option, determine that the Bidder has abandoned the Contract, and thereupon the Proposal and the acceptance thereof shall be null and void, and the deposit accompanying the Proposal shall be forfeited and paid as liquidated damages to the County. The base bid, unit prices and alternatives on the attached and signed Proposal Form are to include and cover the furnishing of all necessary machinery, tools, apparatus and means for performing the work, and the doing of all the above mentioned work, in the manner set forth, described and shown in the Specifications and on the Contract Drawings within the prescribed number of consecutive calendar days after service of written notice from the Owner to proceed with the work.

The successful Bidder shall be required to submit a list containing all parties to which he intends to subcontract any portion of the work. The list shall contain the subcontractor's name, address, work to be sublet and business telephone number.
(NOTE: The Bidder or Bidders must sign here and the address of each must be given. In the case of firms, the firm name must be signed and subscribed to by at least one member. In the case of corporations, the corporate name must be signed by some authorized officer or agent thereof, who shall also subscribe his name and office. The seal of the corporation shall be affixed. (Telephone number to be listed)

The names and addresses of all members of a firm or the names, addresses and titles of every officer of a corporation, or duly authorized agent, as the case may be, must be given here by the member of the firm or by the officer or agent of the corporation who signs the Proposal.

We/I will submit within ten (10) days of request by the county, the Experience and Equipment Certification specified and further understand and are/am aware that the work will be awarded to an approved organization which is properly constituted in experience, capital and equipment.

Prior to, or following, the award of this Contract, the Owner or Engineer may request that We/I supply him with whatever information is needed by him in order to become better familiarized with any of the subcontractors and/or equipment suppliers. It is further stipulated that no change in the names of those persons or organizations will be made unless written application is made with justification and prior approval is granted. It is further agreed that the apparent low bidder will submit within 10 days of a request by the county a detailed list of all subcontractors and equipment suppliers including anticipated dollar values.

We/I agree to accept as full compensation the unit prices stipulated for the contingent construction items that are incorporated into the work by direction of the Engineer in the field.)
NOTE: THIS FORM MUST BE SUBMITTED IN DUPLICATE WITH THE BID

ANNE ARUNDEL COUNTY
DEPARTMENT OF PUBLIC WORKS
ANnapolis, Maryland

Broad Creek II Water Treatment Plant Expansion
Proposal No.: W804001
Project No.: W804000

DATE: _________________

This is to certify that_______________________ has received Addendum No. ___through____ and this bid reflects the changes created by these addenda.

THE CONTRACTOR OR ANY SUBCONTRACTOR ON THIS WORK WILL BE REQUESTED TO COMPLY WITH EXECUTIVE ORDER 11246, ENTITLED "EQUAL EMPLOYMENT OPPORTUNITY" AS AMENDED BY EXECUTIVE ORDER 11375, AND AS SUPPLEMENTED IN U.S. DEPT. OF LABOR REGULATIONS (41 CRF PART 60).

Bidder's Names: ________________________________________________________________

Bidder's Signature: ______________________________________________________________

Bidder's Address:  ______________________________________________________________

Telephone Number:_____________________________________________________________
<table>
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<tr>
<th>Item</th>
<th>Description</th>
<th>Unit Size</th>
<th>Estimated Quantity</th>
<th>Unit Price (dollars)</th>
<th>Total Price (dollars)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Mobilization – This item is a fixed maximum lump sum item not to exceed 5% of total Contract price.</td>
<td>1</td>
<td>LS</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td><strong>Broad Creek II Water Treatment Plant:</strong></td>
<td>1</td>
<td>LS</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>All work shown and specified by the Contract Documents, or otherwise required for the complete project, except for that work specifically covered under Bid Item 1.0.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>The work includes, but is not limited to, constructing new aerators, clarifier, filters, residuals clarifier, recycle and residuals pumping stations, chemical feed system, yard piping, grading, site work, paving, and landscaping. Furnish and install all equipment, materials, labor, structures, site work, piping, test pits, testing, accessories, appurtenances and all other required work.</td>
<td></td>
<td></td>
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## CONTINGENCY UNIT PRICES

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<th>Item</th>
<th>Description</th>
<th>Unit</th>
<th>Estimated Quantity</th>
<th>Unit Price (dollars)</th>
<th>Total Price (dollars)</th>
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<tr>
<td>3</td>
<td>Reinforced Silt Fence.</td>
<td>LF</td>
<td>100</td>
<td>$6.50</td>
<td>$650.00</td>
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<tr>
<td>4</td>
<td>Temporary Seed &amp; Mulch.</td>
<td>SY</td>
<td>500</td>
<td>.70</td>
<td>$350.00</td>
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<tr>
<td>5</td>
<td>Earth Dike.</td>
<td>LF</td>
<td>100</td>
<td>2.25</td>
<td>$225.00</td>
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<td>6</td>
<td>Excelsior Matting.</td>
<td>SY</td>
<td>100</td>
<td>2.00</td>
<td>$200.00</td>
</tr>
<tr>
<td>7</td>
<td>Stone #2 for Sediment Control on Filter Cloth, Including Removal After Completion of Construction.</td>
<td>CY</td>
<td>20</td>
<td>65.00</td>
<td>$1,300.00</td>
</tr>
<tr>
<td>8</td>
<td>Class 3 Excavation w/ Stone Refill/ Offsite Disposal of Unsuitable Material.</td>
<td>CY</td>
<td>20</td>
<td>90.00</td>
<td>$1,800.00</td>
</tr>
<tr>
<td>9</td>
<td>Select Backfill / Offsite Disposal of Unsuitable Material.</td>
<td>CY</td>
<td>10</td>
<td>65.00</td>
<td>$650.00</td>
</tr>
<tr>
<td>10</td>
<td>Borrow Backfill / Offsite Disposal of Unsuitable Material.</td>
<td>CY</td>
<td>20</td>
<td>50.00</td>
<td>$1,000.00</td>
</tr>
<tr>
<td>11</td>
<td>Calcium Chloride.</td>
<td>Ton</td>
<td>2</td>
<td>650.00</td>
<td>$1,300.00</td>
</tr>
<tr>
<td>12</td>
<td>Test Pit Excavation.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>a) Test Pit in County Road</td>
<td>CY</td>
<td>2</td>
<td>350.00</td>
<td>$700.00</td>
</tr>
<tr>
<td></td>
<td>1) First CY</td>
<td>CY</td>
<td>2</td>
<td>250.00</td>
<td>$500.00</td>
</tr>
<tr>
<td></td>
<td>2) Each Additional CY</td>
<td>CY</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>b) Test Pit Outside of Road (0-3 CY)</td>
<td>CY</td>
<td></td>
<td>200.00</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>c) Test Pit Outside of Road (&gt; 3)</td>
<td>CY</td>
<td></td>
<td>125.00</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>d) Test Pit (Includes Traffic Control) Non-destructive</td>
<td>EA</td>
<td>2</td>
<td>650.00</td>
<td>$1,300.00</td>
</tr>
<tr>
<td>13</td>
<td>Flowable Fill.</td>
<td></td>
<td></td>
<td>Not Applicable – Not Used</td>
<td>-</td>
</tr>
<tr>
<td>14</td>
<td>Sheeting and Shoring as Directed by the Engineer – Ordered Left in Place.</td>
<td>MBM</td>
<td>1</td>
<td>950.00</td>
<td>$950.00</td>
</tr>
<tr>
<td>15</td>
<td>Miscellaneous Concrete.</td>
<td>CY</td>
<td>10</td>
<td>325.00</td>
<td>$3,250.00</td>
</tr>
</tbody>
</table>

**TOTAL BID (Sum of items 1 through 15):**

$__________________________

BID PRICE MUST BE WRITTEN AND SHOWN IN NUMBERS. IN CASE OF DISCREPANCY THE WRITTEN AMOUNT WILL SUPERSEDE.

Total time for completion shall be 365 consecutive calendar days. Liquidated damages shall be $1,000 dollars per calendar day.
Basis of Award

The award of the Contract shall be in accordance with Section GP 3.0 of the Anne Arundel County Government July 1, 2006 "Standard Details and Specifications for Construction and Design Manual” and any subsequent revisions thereto and based on the lowest responsible TOTAL BID (Total sum of Items 1 through 15).

________________________________________________________________________________________

(Bidder)

By: ________________________________________________________________________________

(Title)

In accordance with the County Code, Article 8-2-119, please list any affiliation with a County employee(s) or official(s) (Write "none" if there are no affiliations):

________________________________________________________________________________________

________________________________________________________________________________________

________________________________________________________________________________________
ANNE ARUNDEL COUNTY

Broad Creek II Water Treatment Plant Expansion
Proposal No.: W804001
Project No.: W804000

**CONTRACT**

THIS CONTRACT, made this ______ day of ______________ the year ______, by and between ______________________________________________________

_________________hereinafter called the CONTRACTOR, and ANNE ARUNDEL COUNTY, MARYLAND, a body corporate and politic of the State of Maryland, hereinafter called the COUNTY.

WHEREAS, the Contract for constructing Broad Creek II Water Treatment Plant Expansion shown on Drawings, marked Proposal W804001, on file in the Office of the Department of Public Works, subject to all the conditions, covenants, stipulations, terms and provisions contained in the Special provisions, attached hereto, and the Anne Arundel County Government "Standard Details and Specifications for Construction and Design Manual” issued July 1, 2006, and any revisions thereto, as adopted by the Department of Public Works, said Standard Specifications and Standard Details being in all respect made a part hereof by reference as full and with the same effect as if the same had been set forth in full herein, has recently been awarded to the Contractor by the County at and for the sum equal to the aggregate cost of the work, labor, materials and supplies done or furnished, at the prices and rates respectively named therefore in the proposal attached hereto.

AND WHEREAS, it was one of the conditions of said Award that a formal Contract should be executed by and between the contractor and the County evidencing the terms of said Award.

NOW THEREFORE, THIS CONTRACT WITNESSETH, that the Contractor does hereby covenant and agree with the County that he will well and faithfully construct said test wells in accordance with each and every one of the conditions, covenants, stipulations, terms and provisions contained in the above-mentioned Specifications, and as shown on said Drawings, at and for a sum equal to the aggregate cost of the work, labor, materials and supplies done and furnished at the prices and rates respectively named therefore in the Proposal attached hereto, that sum being $_____________________________(excluding change orders), and will well and faithfully comply with and perform each and every obligation imposed upon him by said Specifications, or the terms of said Award.

The Contractor further agrees that for each and every calendar day that the Contractor is in default in completing the work to be done under this Contract, the Contractor shall pay to the County the sum of $1,000 (thousand dollars) per calendar day, which sum is hereby agreed upon as liquidated damages as set forth in the Standard Specifications.
And the County does hereby covenant and agree with the Contractor that it will pay to the Contractor, when due and payable under the terms of said Specifications and of said Award, the above mentioned sum; and it will well and faithfully comply with and perform each and every obligation imposed upon it by said Specifications or the terms of said Award.

And the Contractor and the County do hereby agree that this Contract constitutes a contract under seal and that they intend the twelve year statute of limitations period to apply, as set forth in Courts & Judicial proceedings Article, §5-102, Annotated Code of Maryland.

SERVICE OF PROCESS IN THE EVENT OF SUIT

The Contractor does hereby nominate and appoint ____________________________________________________________

_______________________ who actually resides at ____________________________________________________________

_______________________ in the State of Maryland who will accept service both before and after completion of the Contract and under no circumstances is the Contractor to have the right to withdraw or revoke the agency without the prior written permission of the County.

IN WITNESS WHEREOF, Said ____________________________________________________________

_________________________________________________________________________________

the Contractor, has hereunto set (his) (its) hand and affixed (his) (its) corporate seal, and the County has caused these presents to be signed and the County has caused its corporate seal to be hereunder affixed, duly attested by the Secretary of the County.

WITNESS:

________________________________________________________ (SEAL)
Witness

________________________________________________________ (SEAL)
Contractor

________________________________________________________
Witness

________________________________________________________
Contractor

ANNE ARUNDEL COUNTY, MARYLAND

WITNESS:

________________________________________
John Hammond, Chief Administrative Officer for JOHN R. LEOPOLD, County Executive

Approved as to legal form and sufficiency:

________________________________________
Office of Law

Approved for sufficient funds, and encumbrance of same:

________________________________________
Controller
ANNE ARUNDEL COUNTY, MARYLAND

Broad Creek II Water Treatment Plant Expansion
Proposal No.: W804001
Proposal No.: W804000

CONTRACTOR'S PERFORMANCE BOND

KNOW ALL MEN BY THESE PRESENTS:

That ________________________________, as Principal, hereinafter called Principal, and ________________________________, as Surety, hereinafter called Surety, are held and firmly bound unto the Anne Arundel County, Maryland, a body corporate and politic of the State of Maryland, in the amount of ________________________________ Dollars ($_________) (amount to be 100% of Contract Amount), for the payment whereof Principal and Surety bind themselves, their heirs, executors, administrators, successors and assigns, jointly and severally, firmly by these presents.

WHEREAS, the Principal has entered into a Written Contract dated __________ with the County for Project No.: W804000 Contract No.: W804001 which contract is by reference made a part hereof and hereinafter referred to as the Contract.

NOW, THEREFORE, the condition of this obligation is such, that if the Principal shall well, truly and properly perform and fulfill all the undertakings, covenants, terms, conditions and agreements of said Contract and of all such alterations and modifications thereof as may hereafter be made therein, in the manner and to the extent which said Contract provides for such alterations and modifications, during the original term of said Contract and any extensions thereof which may be granted by the County and agreed upon by the Principal; and if the Principal shall indemnify and save harmless the County from all loss, cost or damage arising out of a default.
hereunder or under said Contract, then this obligation shall be null and void; otherwise it shall remain in full force and effect.

The Surety expressly waives any right to receive NOTICE of extensions of time, or alterations or modifications of the Contract, which are provided for and made pursuant to the terms of, said contract.

PROVIDED, HOWEVER, no right of action shall accrue on this bond to or for the use of any person, firm or corporation whatever other than the County named herein, or its successors in office.

Signed and sealed this __________ day of, ______________________, __________.

In the Presence of:

_____________________________________________

WITNESS:

_____________________________________________

(Contractor)

_____________________________ (SEAL)

Signature of Principal/Corporate Officer

_____________________________________________

(SEAL)

Title

_____________________________________________

Surety

By: _______________________________ (SEAL)

_____________________________________________

Bond No.
ANNE ARUNDEL COUNTY, MARYLAND

Broad Creek II Water Treatment Plant Expansion
Proposal No.: W804001
Project No.: W804000

CONTRACTOR'S LABOR AND MATERIAL BOND

KNOW ALL MEN BY THESE PRESENTS:

That __________________________________________________________________, as Principal, hereinafter called Principal, and _______________________________, as Surety, hereinafter called Surety, are held and firmly bound unto the Anne Arundel County, Maryland, a body corporate and politic of the State of Maryland, hereinafter called the County, for the use and benefit of Claimant, as herein below defined, in the amount of

___________________________________________  Dollars ($_________________________)

(amount of bond to be 50% of Contract Amount), for the payment whereof Principal and Surety bind themselves, their heirs, executors, administrators, successors and assigns, jointly and severally, firmly by these presents.

WHEREAS, the Principal has entered into a Written Contract dated

__________with the County for Project No.: W804000, Contract No.: W804001, which contract is by reference made a part hereof and hereinafter referred to as the Contract.

NOW, THEREFORE, the condition of this obligation is such, that if the principal shall promptly make payment to each and every Claimant, as hereinafter, defined, for all labor, materials, supplies and rental of equipment reasonably required and used or consumed in the performance of the Contract and of all such alterations and modifications of said Contract

B3-1
provides for such alterations and modifications, during the original term of said Contract and any extensions thereof which may be granted by the County and agreed upon by the Principal, then this obligation shall be null and void; otherwise it shall be and remain in full force and effect.

The Surety expressly waives any right to receive notice of extensions of time, or alterations or modifications of the Contract, which are provided for and made pursuant to the terms of, said Contract.

PROVIDED, HOWEVER, anything in said Contract to the contrary notwithstanding, this bond is executed upon and subject to the express conditions and limitations of State Finance and Procurement Article, Section 17-108 and 17-109, Annotated Code of Maryland, as of the date of this contract wherein it is set forth in pertinent part as follows:

**Action on security.**

(a) *In general.* -- Subject to subsection (b) of this section, a supplier may sue on payment security if the supplier:

(1) Supplied labor or materials in the prosecution of work provided for in a contract subject to this subtitle; and

(2) Has not been paid in full for the labor or materials within 90 days after the day that the person last supplied labor or materials for which the claim is made.

(b) *Payment owed by subcontractor.* –

(1) A supplier who has a direct contractual relationship with a subcontractor or sub-subcontractor of a contractor who has provided payment security but no contractual relationship with the contractor may sue on the security if the supplier gives written notice to the contractor within 90 days after the labor or materials for which the claim is made were last supplied in prosecution of work covered by the security.

(2) A notice under this subsection:

(i) Shall state with substantial accuracy the amount claimed and the person to whom the labor or material was supplied; and
(ii) Shall be sent by certified mail to the contractor at the contractor's residence or a place where the contractor has an office or does business.

**Venue; limitations; costs.**

(a) Venue. -- An action on a payment bond required by this subtitle shall be filed in the appropriate court of the county where:

(1) The contract was executed and performed; or

(2) The contractor has its principal place of business.

(b) Limitations period. -- An action on a payment bond required by this subtitle shall be filed within 1 year after the public body finally accepts the work performed under the contract.

Signed and sealed this _____________ day of __________________________., ________.

In the Presence of:

___________________________________________
(Contractor)

WITNESS:

___________________________________________ (SEAL)  
Signature of Principal/Corporate Officer

___________________________________________ (SEAL)  
Title

___________________________________________
Surety

By: _______________________________________

___________________________________________
Bond No.
ANNE ARUNDEL COUNTY, MARYLAND

Broad Creek II Water Treatment Plant Expansion
Proposal No.: W804001
Project No.: W804000

CORPORATE RESOLUTION

RESOLVED, that _______________________________________________ be, and it is hereby authorized to do business and enter into contracts and agreements with Anne Arundel County, Maryland,

RESOLVED, that ________________ and ________________ who are respectfully the ________________ and ________________, or its duly authorized agent(s) of the ____________________________ are authorized to file and sign contracts on behalf of the said Corporation.

AND IT IS FURTHER RESOLVED, that the authority to said officer(s) or agent(s) conferred by this Resolution shall remain open and good until revoked by a formal action of the Board of Directors of the Corporation and due notice of such revocation delivered to the Anne Arundel County, Maryland in writing under the signature of the Secretary or Assistant Secretary of this Corporation, and this authority shall apply to any present or future incumbent of the aforesaid office.

I HEREBY CERTIFY that the above is a true copy of the Resolution of the Board of Directors of ____________________________, passed at a meeting of said Board duly called and held on the day of _________________.______, at which meeting a quorum of said Board of Directors was present and voted.

_________________________________
Secretary

SEAL
ANNE ARUNDEL COUNTY, MARYLAND

Broad Creek II Water Treatment Plant Expansion
Proposal No.: W804001
Project No.: W804000

BID BOND

KNOW ALL MEN BY THESE PRESENT, that we

_________________________________________ hereinafter called the "Principal" and

Company Name

_________________________________________

Surety

as Surety ("Surety"), are held and firmly bound unto Anne Arundel County, Maryland, hereinafter
called the "Owner" in the penal sum of ______________________ Dollars ($__________ ) lawful money of the United States, for the payment of which sum well and
truly make, we bind ourselves, our heirs, executors, administrators and successors, jointly and
severally, firmly by these presents.

THE CONDITION OF THIS OBLIGATION IS SUCH, that whereas the Principal has
submitted the accompanying bid dated ______________________ for the
Broad Creek II Water Treatment Plant Expansion, Anne Arundel County, Maryland.
(Name of Project)

NOW THEREFORE, if the Principal shall not withdraw said bid within the period specified
therein after the opening of the same, or, if no period is specified, within ninety (90) days after said
opening; and within ten (10) days after the prescribed forms are presented to him for signature, enter
into a written contract with the Owner, in accordance with the bid as accepted and give Bond with
good and sufficient surety or sureties, as may be required for the faithful performance and proper
fulfillment of such contract; or in the event of the withdrawal of said bid within the period specified
or the failure to enter into such contract and give such bond within the time specified if the principal
shall pay the Owner the difference between the amount specified in said bid and the amount for
which the Owner may procure the required work or supplies, or both, if the latter amount be in
excess of the former, then the above obligation shall be void, and of no effect, otherwise to remain in
full force and effect.

B5-1
IN WITNESS WHEREOF, the above bonded parties have executed this instrument under their several seals this ______ day of ______________________, ______, the name and corporate seal of each corporate party being hereto affixed, and these presents duly signed by its undersigned representative, pursuant to authority of its governing body.

In the Presence of:

______________________________________
(Contractor)

______________________________ (SEAL)
Signature of Principal/Corporate Officer

______________________________ (SEAL)
Title

______________________________
Surety

By: ________________________________

______________________________
Bond No.
ANNE ARUNDEL COUNTY

Broad Creek II Water Treatment Plant Expansion
Proposal No.: W804001
Project No.: W804000

EXPERIENCE AND EQUIPMENT CERTIFICATION

I. General

a. Legal Title, Address and Phone Number of Organization

____________________________________________________________________
____________________________________________________________________
____________________________________________________________________
____________________________________________________________________
____________________________________________________________________

b. Maryland Representative's Name, Title and Address.

____________________________________________________________________
____________________________________________________________________
____________________________________________________________________
____________________________________________________________________
____________________________________________________________________

(Check one)  Corporation _____  Co-Partnership_____  Individual _____

II. Experience

a. Indicate type of contracting undertaken by your organization and years experience.

<table>
<thead>
<tr>
<th>General</th>
<th>Sub</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
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</table>

<table>
<thead>
<tr>
<th>Type</th>
<th>Years</th>
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</table>

<table>
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<tr>
<th>Type</th>
<th>Years</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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</tr>
</tbody>
</table>
b. State construction experience of principal members of your organization.

**Construction Experience**

<table>
<thead>
<tr>
<th>NAME</th>
<th>TITLE (As Pres., Mgr, etc.)</th>
<th>CONSTRUCTION EXPERIENCE YEARS</th>
<th>TYPE OF WORK (Sewer, Hwy, Bridges, Paving, etc.)</th>
<th>IN WHAT CAPACITY (Supt, Foreman)</th>
</tr>
</thead>
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</table>


c. Give any special qualifications of firm members
(Registered Engineer, Surveyors, etc.)

____________________________________________________________________

____________________________________________________________________

____________________________________________________________________

d. List Principal projects completed by your organization.

<table>
<thead>
<tr>
<th>Description</th>
<th>Gen. or Sub (If sub, what type of work)</th>
<th>Your Contract Amount</th>
<th>Year</th>
<th>Reference</th>
</tr>
</thead>
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</table>


e. Have you ever failed to complete any work awarded to you? ________________

If so, where and why? _______________________________________________________________________

____________________________________________________________________

____________________________________________________________________

____________________________________________________________________
NOTE: THIS FORM TO BE SUBMITTED BY APPARENT LOW BIDDER WITHIN TEN DAYS OF REQUEST BY THE COUNTY

f. Has your firm been assessed liquidated damages within the last three years? If so, explain circumstances. *(Attach separate sheet)*

III. Financial Capability

The following financial data shall be provided. If the Bidder is a subsidiary of another firm, then the information requested should be provided for both the Bidder and the parent organization, as it may be applicable to the Bid.

a. The Bidder's most recent Form 10K, as filed with the U.S. Securities and Exchange Commission ("SEC") and all 100s since the last 10K,

b. All Bidders not filing a Form 10K with the SEC should submit the following information:

1. Federal Tax Returns for the last three (3) years;

2. Audited financial statements for the past three (3) fiscal years to include, at a minimum, income statement, balance sheet, and statement of changes in financial position;

3. Copies of quarterly financial reports since the last audited statement;

4. Any material changes in the mode of conducting business, bankruptcy proceedings, and mergers or acquisitions for the past three years, as well as any disclosure of any potential mergers or acquisitions; and

5. Any and all lawsuits filed against the Bidder since January 1, 1988 and a statement as to the outcome or current status of each such lawsuit.

d. A full and complete description of the legal and financial relationships among all entities which will be bound by the terms and conditions of the Contract including any entities which will guarantee the obligations of, or provide financial support to, any such parties.
IV. Bidder Certification

The above statements are certified to be true and accurate and we have the equipment, labor, supervision and financial capacity to perform this Contract, either with our organization, or with subcontractors.

Dated at ________________________________ this _____ day of ________________________________.

By: ________________________________

_________________________________
(Title of Person Signing)  

_________________________________
(Name of Organization)  

State of ________________________________

County of ________________________________

________________________________________ Being duly sworn states that he/she
Name
is ________________________________ of ________________________________
(Office) (Name of Organization)

and that the answers to the foregoing questions and all statements therein contained are true and correct.

Sworn to before me this ________________________________ day of ________________________________.

_________________________________
Notary Public

My Commission Expires

_________________________________
NOTE: THIS FORM MUST BE SUBMITTED IN DUPLICATE WITH THE BID

ANNE ARUNDEL COUNTY

Broad Creek II Water Treatment Plant Expansion
Proposal No.: W804001
Project No.: W804000

LIST OF SUBCONTRACTORS AND EQUIPMENT SUPPLIERS

<table>
<thead>
<tr>
<th>Subcontractor's Type of Work or Supplier's Type of Equipment</th>
<th>Name</th>
<th>Address</th>
<th>Percent of Total Contract</th>
<th>MBE SBE or WBE</th>
</tr>
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</table>
SPECIAL PROVISIONS

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SP-08 MANUFACTURER'S CERTIFICATES
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SECTION SP
SPECIAL PROVISIONS

SP- 01 DESCRIPTION OF WORK

A. The work generally consists of, but is not limited to, the following improvements at Anne
Arundel County’s Broad Creek II Water Treatment Plant (WTP):

1. Two new cascade aerators
2. One new vertical paddle-wheel flocculator
3. One new SuperPulsator clarifier system
4. One new Greenleaf filter system
5. Three new vertical turbine clearwell pumps
6. Modifications to two existing lime silos and new lime feed systems
7. Three new polymer feed units
8. Modifications to existing sodium hypochlorite system, including new injector and
new bulk storage tank
9. New residuals recycling system, including modifications to existing sludge
holding tank, new submersible mixer, two prefabricated pump stations with self-
priming pumps
10. New distributed control system, including new programmable logic controllers
(PLCs) and redundant loop fiber optic cable system
11. New 480-volt electric service
12. New generator and automatic transfer switch (ATS)

B. The work shall include all appurtenant civil, structural, mechanical, electrical, and
instrumentation and control work associated with the above scope.

SP- 02 CONTRACT DOCUMENTS

A. The contract documents governing the work are defined in the Anne Arundel County
Government July 1, 2006, “Standard Details and Specifications for Construction and
Design Manual”, hereinafter referred to as the Standard Specifications. The Plans consist
of the set of contract drawings entitled “Broad Creek II Water Treatment Plant”, and
subsequent addenda thereto:

1. Project Manual
   a. This Project Manual consists of bidding and contract forms,
      Special Provisions, Technical Specifications, Appendices, and
      subsequent addenda thereto.
   b. In case of conflict between Standard Specifications and other
      Project Manual requirements, other Project Manual
      requirements shall be given precedence.

SP- 03 SUBSURFACE CONDITIONS

A. Soil borings were performed in connection with the geotechnical investigation for the
project by GeoConcepts Engineering, Inc. The geotechnical investigation is included in
Appendix C. This report is for informational purposes only and should not be considered
part of the contract documents. It shall be expressly understood by the Contractor that
the County will only be responsible for the information or data shown at the individual
boring locations. Any deduction, interpretation, or conclusion drawn therefrom by the Contractor as to the subsurface or latent physical conditions beyond the boring location will be entirely at the risk of the Contractor and will not be the responsibility of the County.

B. The opinions expressed in this report are those of the geotechnical engineer and represent their interpretation of the subsoil conditions, tests and results of analyses that they performed. Should the data contained in the report not be adequate for the Contractor’s purposes, the Contractor may make their own investigations, tests and analyses prior to bidding.

SP- 04 MEASUREMENT AND PAYMENT
A. Contractor shall be paid on a lump-sum basis for all work on this project. Provisions in Standards Specifications regarding measurement and payment of unit prices shall be deleted. Contingent items are line item payments.

SP- 05 WAIVER OF BIDDING CLAIMS
A. Each bidder agrees to waive any claim it has or may have against the Owner, the Engineer, and their respective employees, arising out of, or in connection with, the administration, evaluation, or recommendation of any bid.

SP- 06 PROGRESS SCHEDULE AND CONSTRUCTION SEQUENCE
A. The Contractor will incorporate the requirements shown below into the progress schedule required by GP-8.04.

B. Construction Schedule: Critical Path Method (CPM).
   1. The schedule shall be as specified below in lieu of the bar chart schedule.
   2. Within 15 days after construction start date in Notice to Proceed, prepare and submit a preliminary schedule in time-scale format, indicating planned operations during first 60 days.
   3. Within 45 days after construction start date in Notice to Proceed, submit 5 copies of a complete network analysis system, showing usage of entire Contract Time, consisting of detailed network, mathematical analysis, and network diagram. Present schedule in the form of a Precedence Diagramming Method (PDM) CPM Network Diagram. Use finish-finish, finish-start, or start-start only. Start-finish will not be used.
      a. Show order and interdependence of activities and sequence in which Work will be accomplished. Show how the start of a given activity is dependent on completion of preceding activities and how its completion restricts start of following activities.
      b. Show the following detailed network activities on network diagram, in addition to construction activities:
         (1) Submittal and approval for all submittals.
         (2) Procurement of critical materials and equipment.
         (3) Fabrication of materials and equipment, their installation and testing.
         (4) Specified intermediate milestone or completion dates.
         (5) Show duration of each activity in working days, with minimum of 1 working day and maximum of 20 working days for any on site activity, with material and equipment related delivery activities exempt from the maximum duration requirement.
c. Group related activities on network and highlight activities on critical path. Time-scale network using units of approximately 1/2 inch equals 1 week or other suitable scale approved by Engineer. Indicate weekends and holidays. Where slack exists, show activities at earliest time they are scheduled to be accomplished. Use sheet size 22-inch by 34-inch, minimum, or per Engineer’s approval. Place title and revision block in lower right-hand corner.

d. Include tabulation of each activity shown on detailed network diagram in the mathematical analysis. Furnish following information as minimum for each activity:

1. Activity node numbers (I/J).
2. Activity description.
3. Duration of activity in units of working days.
4. Earliest start date (by calendar date).
5. Earliest finish date (by calendar date).
6. Scheduled or actual start date (by calendar date).
7. Scheduled or actual finish date (by calendar date).
8. Latest start date (by calendar date).
9. Latest finish date (by calendar date).
10. Slack or Float (working days).
11. Activity percent complete and remaining duration.
12. Monetary value of activity.
13. Responsibility code for each activity (Prime Contractor, subcontractors, suppliers, and the County).
14. Manpower required by trade and by total.
15. Equipment required.

e. List activities in sorts or groups in mathematical analysis:

1. Ascending activity node number (I/J).
2. Amount of total float, then in order of activity number.
3. Latest start date, then in order of activity number.
4. Responsibility in order of earliest start date.

f. To facilitate review of payment requests, submit Schedule of Values.

g. Furnish initial submittal and revisions in 5 copies.

4. Review of system:

a. Participate in Engineer’s review and evaluation of proposed network diagrams and analysis. Resubmit revisions necessary as a result of this review to Engineer within 10 days after conference. Allow 20 days for Engineer’s checking and further action.
b. Progress payments will be withheld pending attainment of mutually acceptable schedule. Engineer’s review and mutual acceptance of Contractor’s schedule is for conformance to requirements of the Contract Document. Review and mutual acceptance by Engineer of Contractor’s schedule does not relieve Contractor of any of its Contract Document responsibilities for accuracy or feasibility of schedule, or of Contractor’s ability to meet interim project milestone dates and Contract completion date, nor does such review and mutual acceptance expressly or impliedly warrant, acknowledge or admit the reasonableness of the logic, durations, manpower, or equipment loading of Contractor’s schedule.

c. Use mutually accepted schedule for planning, organizing, directing, and executing Work and for reporting progress.

d. To make subsequent changes to method of operating and scheduling, submit written request separately to Engineer for review, stating reasons for change(s). For major changes, Engineer may require Contractor to revise and submit, without additional cost to the County, all affected portions of network diagram and mathematical analysis to show effect on entire project. Change may be considered major if time estimated or actually used for an activity or logic of sequence of activities is so varied from original plan that there is reasonable doubt about effect on Contract completion date or dates. Changes affecting activities with adequate slack time shall be considered minor, except that accumulation of minor changes may be considered major when their cumulative effect might affect Contract completion date. Incorporate mutually accepted changes into next monthly update. Progress payments may be withheld pending mutual acceptance of schedule changes.

5. Scheduling software must be Primavera. Furnish compatible software and updates to Engineer within 30 days after date in Notice to Proceed. The software will become the property of the County. Submit to Engineer CPM schedule data on disk, CD, or acceptable product with each schedule submittal and update.

6. Submit at 30-day intervals a report of actual construction progress by updating mathematical analysis sorts and graphically generating and reproducing a copy of current network diagram. Include field orders and all pending and approved change orders in updated schedule. Note revisions causing changes in the detailed network. Revise network diagram as described above and as necessary for clarity.

7. Show activities or portions of activities completed during reporting period and their total value as basis for Contractor’s periodic request for payment. Coordinate these activities or portions of activities with breakdown for lump sum items herein. State percentage of Work actually completed and scheduled as of report date and progress along critical path in terms of days ahead or behind mutually accepted schedule dates.

a. If project is behind schedule, report progress along other paths with negative slack. Engineer will review percentage of work actually completed following procedures set forth in GP-9.06.

b. If Contractor fails to submit required monthly reports and updates within time prescribed, Engineer may withhold approval of progress payment estimates until Contractor
submits acceptable required reports and updates. Submit 3 copies of report for each update.

8. Simultaneously submit a narrative report with updated analysis, which shall include but not be limited to description of problem areas, current and anticipated delaying factors, their impact, and an explanation of corrective actions taken or proposed. Include all changes, change orders and field orders.

9. Float or slack is defined as difference in working days between earliest start date and latest start date, or difference between earliest finish date and latest finish date of any activity of mathematical analysis of B.3.d herein. Float or slack is not for exclusive use of Contractor or the County.

10. Requests for Contract Time extension:
   a. Accompanied by revised schedule, or portion thereof, and mathematical analysis.

Based on affect of controlling delays to the Work as a whole.

11. Progress Payments:
   a. Include with each breakdown its proper share of overhead, profit, and applied General Conditions. Subdivide Work into activities on Construction Schedule in sufficient detail. Coordinate with breakdowns submitted herein, to serve as basis for progress payments during construction. Refer to GP-9.06 for additional requirements for monthly estimates.
   b. Prepare schedule of breakdown in form acceptable to Engineer and furnish with data to substantiate its correctness as Engineer may require.

12. In preparing the Construction Schedule, the Contractor shall plan appropriate time, coordination, and sequencing of activities with respect to the following specific priorities and constraints:
   a. The plant must be maintained in operation at all times during construction. However, temporary shutdowns will be needed to enable the Contractor to make connections to existing structures or to modify existing structures and equipment. The Contractor will submit his complete work plan for each shutdown in accordance with Section 5.04 of the General Provisions. The plans will include the work to be completed prior to a shutdown, what materials and equipment will be on site prior to and during the shutdown, the manpower required to complete the work expeditiously, backup plans in the event that the work cannot be completed according to the plan, and any other information required by the Engineer.
   b. The Contractor’s work plan will be reviewed to the extent necessary to satisfy the Engineer that the work plan meets the scheduling requirements, that the work will be completed safely and expeditiously.
   c. The Contractor will notify the Engineer in writing when he wants to schedule a shutdown at least seven days in advance of the requested start date to enable the Engineer to take appropriate action, and to allow the County to fill its water storage tanks. Some shutdowns may require more than 7-days notice as
specified or shown on the Contract Plans. No shutdowns will take place without the concurrence of the Engineer.

d. Maintaining treated water flow from the Broad Creek II WTP is critical to providing adequate water supply to Zone 210, and tie-ins requiring plant shutdowns shall be limited to 12 hours. For any work requiring cleaning and disinfection, the Contractor shall include the time for cleaning and disinfection (including sampling) within the 12-hour shutdown. Both the need for cleaning and disinfection and the disinfection method shall be determined by the Engineer. At a minimum, tie-ins to the existing filter effluent chamber, existing clearwell, and existing clearwell pumps’ discharge header will require cleaning and disinfection.

e. In general, the Contractor shall construct the new, parallel process train while keeping the existing plant in operation.

f. To the extent possible, temporary plant shutdowns should occur between November 1 and March 30.

g. To the extent possible, the number of temporary plant shutdowns should be minimized.

h. At a minimum, the following considerations and constraints involving individual process work should be observed and included in the construction sequence:

(1) Cascade aerators/recycle system discharge. Maximum shutdown duration shall be 4 hours. Recycle system discharge connects to cascade aerator influent. New tee/butterfly valve assembly shall be pre-assembled. Existing aerator influent piping must be drained prior to cutting pipe. Flange coupling adapters or mega-flanges shall be used to install the new tee/butterfly valve assembly. More room will be available to accomplish this work if it is performed prior to constructing the new SuperPulsator clarifier.

(2) SuperPulsator clarifier system. No shutdowns.

(3) New Greenleaf filter system (filter influent interconnection, filter effluent interconnection, clearwell interconnection). No shutdowns. Construct new filter system with three, new butterfly valves—one for each connection to existing. After new treatment train is operational, remove existing filters from service and connect filter influent pipes, filter effluent chambers, and clearwells.

(4) Vertical turbine clearwell pumps’ discharge. Maximum shutdown duration shall be 4 hours. New tee/butterfly valve assembly shall be pre-assembled, disinfected. Existing clearwell discharge piping must be drained prior to removing existing elbow. Replace existing elbow with new tee/butterfly valve assembly. More room will be available to accomplish this work if it is performed prior to constructing the new Greenleaf filter system and new clearwell.
(5) Lime feed system. No shutdowns. Only one lime feed system may be out of service at a time. Each lime silo must be emptied before existing bin activators can be removed. After new treatment train is operational, including new lime feed point, remove existing lime feed point from service and connect new lime slurry pipe to existing feed point.

(6) Polymer feed units. No shutdowns.

(7) Sodium hypochlorite system. No shutdowns. Plant has two existing, sodium hypochlorite transfer pipes, and both must be relocated around the new Electrical Room. Only one sodium hypochlorite transfer system may be out of service at a time.

(8) Residuals recycling system.
   (A) Work includes relocation of existing, 6-inch-diameter, Pulsator clarifier blowdown piping; relocation of existing, 4-inch-diameter, Pulsator clarifier drain piping; connection of new 24-inch-diameter spent filter backwash drain piping to existing 24-inch-diameter spent filter backwash drain piping; modifications to existing transfer sump; and modifications to existing sludge holding tank. Blowdown and drain piping must be relocated prior to excavation for new SuperPulsator clarifier. New blowdown piping will allow the clarifier blowdown to be directed to either the existing sludge holding tank or to the existing transfer sump.
   (B) Tie-in of blowdown piping at existing transfer sump should be performed between backwashes. Backwash frequency is typically every two days in summer, daily in winter.
   (C) New spent filter backwash connection must be made before new treatment train can be put into operation. New spent filter backwash connection to existing spent filter backwash piping should be performed between backwashes. New spent filter backwash piping will allow spent filter backwash to be directed to either the existing sludge holding tank or to the existing transfer sump.
   (D) Recycle pumping system must be operational prior to modifications to existing sludge holding tank. Tie-in of discharge from recycle pumping system should be part of cascade aerator shutdown (above).
   (E) Modifications to existing sludge holding tank must be made prior to modifications to existing transfer sump. Since clarifier blowdown and spent filter backwash will be capable of being directed either to the existing sludge holding tank or to the existing transfer sump, one tank can be modified while the other is used as a wetwell for temporary, portable pumping to the sanitary sewer. The modified sludge holding tank (new residuals clarifier) can be used as a wetwell for the temporary, portable pumps
while modifications are made to the existing transfer sump (new blend tank).

(9) Distributed control system. Broad Creek II WTP must be operated manually while the existing PLC is disconnected and the new PLC is connected. Manual operation should minimal (4 hours), in order to maintain treated water flow from the Broad Creek II WTP. Prior to the transition from existing to new the new PLC panel shall be installed and operational (programmed). New control cable and conduits between the existing PLC and the new PLC shall be installed. Equipment shall be disconnected from the existing PLC, connected to new PLC, tested, and put back into operation.

(10) Electrical service. Shutdowns of both the Booster Pump Station (BPS) and the WTP will be required to connect motor control centers (MCCs) to new electrical service. New electrical service, including ATS, terminal box, duct bank, and feeders, shall be installed, tested, and ready for connection prior to shutdowns.

(A) BPS shutdown. Maximum shutdown duration shall be 4 hours Disconnect existing feeder; connect new feeder

(B) WTP shutdown. Maximum shutdown duration shall be 4 hours. MCC-2 shall be in place, energized, and tested prior to shutdown. Disconnect existing feeder; connect new feeder.

(11) Generator. No shutdowns.

SP- 07 MANUFACTURER’S EQUIPMENT CERTIFICATION

A. At the time of submitting shop drawings, submit on the form included as Appendix D, a certification from each manufacturer of the equipment or system listed below that the manufacturer has examined the contract drawings and specifications and that the proposed equipment, component, or system meets or exceeds the contract requirements, is suitable for its intended purpose and installation, and will provide satisfactory performance at the design conditions and criteria as specified.

1. Cascade aerators
2. SuperPulsator clarifier system
3. Greenleaf filter system
4. Vertical turbine clearwell pumps
5. Lime feed systems
6. New residuals clarifier mechanism
7. Recycle and residuals clarifier feed pumps
8. Generator

B. Shop drawings will not be reviewed prior to the receipt by the engineer of an acceptable manufacturer’s equipment certification.

C. The manufacturer’s equipment certification must be signed by an officer of the basic corporation, partnership, or company manufacturing the equipment, and witnessed by a notary public.
SP-08 MANUFACTURER’S CERTIFICATES

A. Where manufacturer’s certificates are required to be submitted in the technical specifications, they shall be submitted in accordance with these provisions.

B. The Contractor shall furnish the Engineer with manufacturer’s certificates stating that the equipment and products have been installed under either the continuous or periodic supervision of the manufacturer’s field representative, that they have been adjusted and initially operated in the presence of the manufacturer’s field representative, and that they are operating in accordance with the specified requirements to the manufacturer’s satisfaction.

C. A manufacturer’s certificate for equipment, a product, or component of a product shall indicate test results demonstrate that the equipment, product, or component of a product meets the requirements of the contract documents. An affidavit consisting of a sworn statement by an officer of the company manufacturing the equipment or product indicating that the information on the certificate is true and accurate shall accompany the certificate.

D. A statement originating from the Contractor, or any of his subcontractors, suppliers, or any other agent which merely indicates that a particular item of equipment, product, or component of a product meets the requirements of the contract documents shall not be considered to be a valid manufacturer’s certificate. Any such submittal made in this manner will not be approved and the corresponding equipment, product, or component of a product shall not be finally accepted.

E. A copy of all manufacturers’ certificates shall be bound in each Operations and Maintenance Manual.

SP-09 SHOP DRAWINGS

A. Submit shop drawings in accordance with GP-5.04 and the individual specification sections. Unless otherwise noted, submit ten (10) copies of each shop drawing for approval. Four (4) copies will be returned to the Contractor.

B. Each shop drawing submitted shall have affixed to it the following Certification statement, signed by the Contractor: “By this submittal, I hereby represent that I have determined and verified all field measurements, field construction criteria, materials, dimensions, catalog numbers and pertinent data and I have checked and coordinated each item with other applicable drawings and all Contract requirements.”

SP-10 OPERATION AND MAINTENANCE (O&M) MANUALS

A. Submit operation and maintenance manuals in accordance with GP-5.04.8 and the individual specification sections, with the following revisions:

1. Submit an electronic format of the O&M manual. The electronic format shall contain all of the information included in the paper copy of the manual. It shall be in Adobe Acrobat (.pdf) format, readable through the latest version of Adobe Acrobat Reader. Format shall be subject to approval of the Engineer. When creating the Acrobat Reader file, the following rules shall be observed.

   a. Convert the document directly from the authoring software. Avoid scanning documents. Text shall remain editable in the Acrobat format.

   b. Hyperlinks are acceptable, but shall be internal rather than “cross-document” links. Wherever possible, provide only one .pdf file for each system or piece of equipment. Provide bookmarks within the document to assist in navigation.
c. Resolution shall be set to achieve files of a practical and reasonable size, while retaining clarity when viewed on-screen or printed.

d. The submitted file shall not contain any file locking mechanisms that would prevent the subsequent addition of pages, bookmarks, text, or hyperlinks.

e. For conversion of AutoCAD drawings, pen weights and colors shall be used in the conversion such that the Acrobat files can be viewed and printed as they would appear if printed directly from AutoCAD.

2. Submit two paper copies of the O&M manual in preliminary draft form
3. Submit two paper copies of the final draft O&M manual.
4. Submit four paper copies of the final O&M manual. At the same time, submit five copies of the final electronic format O&M.

SP- 11 APPROVAL OF MATERIALS

A. Only new materials and equipment shall be incorporated into the Work. All materials and equipment furnished by the Contractor shall be subject to the inspection and approval of the Engineer. No material shall be delivered to the site without prior approval of Engineer.

B. Facilities and labor for handling and for inspection of all materials and equipment shall be furnished by Contractor. If directed, either prior to beginning or during progress of the work, the Contractor shall submit samples of materials for such special tests as may be necessary to demonstrate that they conform to the specifications. Such samples shall be furnished, stored, packed, and shipped as directed at the Contractor’s expense. Except as otherwise noted, the Contractor shall make arrangements for and pay for the tests.

C. The Contractor shall schedule the submittal of data and samples sufficiently early to permit consideration and approval before materials are necessary for incorporation in the Work. Any delay of approval resulting from Contractor’s failure to submit samples or data in a timely manner shall not be used as a basis of claim for additional costs or time.

D. The materials and equipment used on the work shall correspond to the approved samples or other data.

E. In accordance with Code of Maryland regulations (COMAR) 26.04.01.33, Direct and Indirect Additives, suppliers of water shall only use only products (any materials that come in contact with water intended for use in public water supply) that meet the applicable American National Standards Institute/NSF International (ANSI/NSF) standards for direct or indirect drinking water additives. The products can also be certified by an organization accredited by the ANSI for such testing (i.e International Association of Plumbing and Mechanical Officials Research and Testing, Ontario CA, Underwriters Laboratory, Northbrook IL, and Water Quality Association, Lisle IL).

SP- 12 MANUFACTURER’S INSTRUCTIONS FOR INSTALLATION

A. When Contract Documents require that installation of work shall comply with manufacturer’s printed instructions, obtain and distribute copies of such instructions to parties involved in the installation, including eight copies to Engineer.

B. Maintain one set of complete instructions at the job site during installation and maintain one set for record drawings.

C. Handle, install, connect, clean, condition, and adjust products in strict accord with such instructions and in conformity with specified requirements.
D. Perform work in accordance with manufacturer’s instructions. Do not omit any preparatory step or installation procedure unless specifically modified or exempted by Contract Documents.

SP-13 TRANSPORTATION AND HANDLING

A. Arrange deliveries of products in accordance with construction schedules, coordinate to avoid conflict with work and conditions at the site.
   1. Deliver products in undamaged condition, in manufacturer’s original containers or packaging, with identifying labels intact and legible.
   2. Immediately upon delivery, inspect shipments to assure compliance with requirements of Contract Documents and approved submittals, and that products are properly protected and undamaged.

B. Provide equipment and personnel to handle products by methods to prevent soiling or damage to products or packaging.

SP-14 STORAGE AND PROTECTION

A. Furnish covered, weather-protected storage structures providing a clean, dry, noncorrosive environment for all mechanical equipment, valves, architectural items, electrical and instrumentation equipment, and special equipment to be incorporated into this project. Storage of equipment shall be in strict accordance with the instructions for storage by each equipment supplier and manufacturer including heating and moisture controls, use of storage lubricants, etc. Corroded, damaged, or deteriorated equipment and parts shall be replaced before acceptance of the project. Equipment and materials not properly stored will not be included in a payment estimate.

B. Store products in accordance with manufacturer’s instructions, with seals and labels intact and legible.
   1. Store products subject to damage by the elements in weather-tight enclosures such as buildings or trailers which have a concrete or wooden floor, a roof, and fully closed walls on all sides.
   2. Maintain temperature and humidity within the ranges required by manufacturers’ instructions.
   3. Protect mechanical and electrical equipment from contamination by dust, dirt, water, atmosphere moisture, chemicals, insects, animals, vandals, or other sources of damage.
   4. Store fabricated products above the ground, or floor, on blocking or skids. Prevent soiling or staining. Cover products which are subject to deterioration with impervious sheet coverings. Provide adequate ventilation to avoid condensation.
   5. Provide heated storage space for materials subject to damage by freezing or low temperatures.
   6. Store loose granular materials in a well-drained area on solid surfaces to prevent mixing with foreign matter.

C. All materials and equipment to be incorporated in the work shall be handled and stored by the Contractor before, during, and after shipment in a manner to prevent warping, twisting, bending, breaking, chipping, rusting, and any injury, theft, or damage of any kind whatsoever to the material or equipment.

D. Cement, sand, and lime shall be stored under a roof and off the ground and shall be kept completely dry at all times. All structural and miscellaneous steel, and reinforcing steel shall be stored off the ground or otherwise to prevent accumulations of dirt or grease, and
away from water. Beams shall be stored with the webs vertical. Precast concrete beams and slabs shall be handled and stored in a manner to prevent accumulations of dirt, standing water, staining, chipping, or cracking. Brick, block, and similar masonry products shall be handled and stored in a manner to reduce breakage, chipping, cracking, dampness, and spalling.

E. All damaged materials, in the sole opinion of Engineer, shall be promptly removed from the site and the Contractor shall receive no compensation for the damaged material or its removal.

F. Arrange stored items in a manner to provide easy access for inspection. Make periodic inspections of stored products to assure that products are maintained under specified conditions, and free from damage or deterioration.

G. Protection After Installation: Provide substantial coverings as necessary to protect installed products from damage from traffic, fallen objects, incidental contact by equipment or other materials during placement, and any other subsequent construction operations. Remove coverings prior to testing.

H. Equipment shall not be delivered to the site more than two months prior to installation without written authorization from Engineer.

I. All equipment shall be stored fully lubricated with oil, grease, etc. unless otherwise instructed by the manufacturer.

J. Moving parts shall be rotated a minimum of once weekly to insure proper lubrication and to avoid metal-to-metal “welding”. Upon installation of the equipment, and with full compliance with manufacturer’s recommendations, the Contractor shall start the equipment, at least half load, once weekly for an adequate period of time to insure that the equipment does not deteriorate from lack of use.

K. Lubricants shall be changed upon completion of installation and as frequently as required thereafter during the period between installation and acceptance. Mechanical equipment to be used in the work, if stored for longer than ninety (90) days, shall have the bearings cleaned, flushed, and lubricated prior to testing and startup.

SP- 15 HOURS OF WORK

A. The Contractor’s working hours shall be 7:00 am to 3:30 pm Monday through Friday.

B. No work requiring the presence of Engineer or an Inspector will be permitted on Sunday or on legal County holidays, including County designated Service Reduction Days.

SP- 16 ACCESS TO EXISTING FACILITIES DURING CONSTRUCTION

A. Access to existing facilities shall be maintained during construction. Access to the west side of the plant is via a road between the ground storage tank and the Treatment Building. Temporary blockage of this road, if necessary, must be carefully coordinated with plant staff.

SP- 17 LIMITS OF WORK AREA

A. Confine construction operations within the Limit of Work shown on the Drawings.

1. No work is permitted outside the Limit of Work.

2. No disturbance of property is permitted outside the Limit of Disturbance.

3. Storage of equipment and materials outside of the Limit of Work is used only with Owner’s written approval.

4. Limits of the Contractor staging/storage areas are shown on the Drawings. Any additional staging/storage/stockpile area required to complete the work will be
offsite, and is the Contractor’s responsibility to coordinate at the Contractor’s
cost.

SP- 18 MANUFACTURER’S FIELD SERVICES

A. Provide all labor, materials and instruments to perform all field tests of equipment. Make
changes, adjustments and replacements required to comply with the requirements of the
Contract Documents.

B. Perform field tests as specified in this Section and in individual specification sections.

C. Final acceptance tests shall consist of the following checks as a minimum:

1. That the equipment is properly lubricated, adjusted and aligned.

2. That the equipment meets the specified performance requirements in every detail
and performs its intended function without any signs of possible malfunction.

3. Where equipment is capable of operation in more than one mode or equipment
performs more than one function, each operational mode or function shall be
checked for proper performance.

4. All controls, both mechanical and electrical, shall be checked individually for
proper connection and operation.

END OF SECTION
SECTION 01200
ENGINEER’S OFFICE

Except as indicated herein, work shall be in accordance with the pertinent requirements of Standard Specifications Section 01200.

01200.02 A. MATERIALS FURNISHED BY THE COUNTY
Delete Paragraph 1 in its entirety. Replace with the following:

1.01 The County will provide the office space including potable water, sanitary connection, and power.

A. Provide only the following office equipment in accordance with 1200.02 C.3:

1. 12 chairs
2. 2 utility tables
3. 2 stools
4. 1 plan rack
5. 2 utility tables
6. 1 drafting tables
7. 1 fire extinguisher
8. 1 first aid kit
SECTION 01510
TEMPORARY CONSTRUCTION FACILITIES AND CONTROLS

PART 1 GENERAL

1.01 DESCRIPTION

A. Provide all required temporary construction facilities, controls, and environmental protection. Erosion and sediment control shall be as shown on the Plans and specified in Standard Specifications.

B. This section addresses:
   1. Temporary fencing
   2. Barricades
   3. Pedestrian bridges
   4. Field office facilities for the Contractor
   5. Temporary utilities
   6. Protection of installed work
   7. Project sign
   8. Maintenance of traffic
   9. Temporary Storage Areas
   10. Hazardous material identification and material safety
   11. Security
   12. Access roads and parking
   13. Cleaning during construction
   14. Environmental protection
   15. Flotation Prevention
   16. Removal of utilities, facilities and controls

1.02 SUBMITTALS

A. Comply with Section SP-09

B. Provide Temporary Facility Layout
   1. Show proposed locations and sizes of offices, shops, storage areas, fencing, access roads, parking areas, temporary stationary equipment, and similar facilities.
      a. Identify routes, cross sections and drainage facilities for proposed access roads.
      b. Identify storage yards and storage buildings. Include both gravel and paved areas.
   2. The Engineer shall allocate available space where onsite space for temporary facilities is limited.
   3. Should Contractor require space in addition to that allocated, Contractor shall make his own arrangements for storage of material and equipment in locations off the construction site at no additional cost to the Owner.
4. Locate all temporary facilities so as not to impede or prevent the principal function of existing facilities in the area.

C. Provide Temporary Utility Layout at the pre-construction meeting. Include the following:
   1. Plans of proposed temporary electric power and distribution.
   2. Potable water
   3. Sanitary facilities
   4. Telephone

D. Submit proposed plan to maintain existing plant operations during construction. Include traffic routing plans.

1.03 TEMPORARY CONSTRUCTION FACILITIES
A. General
   1. Use material of a size, shape, and strength that is suitable for the use intended.
   2. Conduct all construction operations so as to cause as little inconvenience as possible to the general public, the County, and its employees.
   3. Erect and maintain signs, fences, barricades and pedestrian bridges and provide guards and flagmen wherever required to protect the public.
   4. Take positive measures to prevent the entry of unauthorized persons and animals to the Work site and storage areas.
   5. The Engineer shall approve the location of all temporary facilities and utilities before they are delivered to the project site, constructed, or erected.

B. Temporary Fencing
   1. Provide temporary fencing as required to enclose and protect excavation, storage and operating areas.
   2. Fencing shall be neat in appearance and shall be approved by the Engineer.
   3. Unless otherwise indicated, fences shall be at least 6 feet high.

C. Barricades
   1. Barricade or close all openings in roadways, floors, walls or other parts of structures or walkways while the openings are not in regular use.
   2. Make barricades structurally sound, suitable for intended use, neat in appearance, and of a size and arrangement approved by the Engineer.

D. Pedestrian Bridges
   1. Construct bridges for pedestrians in those areas where it is necessary to remove existing sidewalks.
   2. Construct bridges of suitable materials in accordance with local or State requirements.
   3. Make pedestrian bridges at least 6 feet wide or as necessary to accommodate the normal traffic flow at the particular location.

E. Field Office Facilities for the Contractor
   1. Contractor shall furnish adequate field office facilities for his own use for the duration of this Contract.
2. Locate these facilities as shown on the Drawings or as approved by the Engineer.

3. Provide telephone and electric service and pay for their installation and use.

4. Post a sign identifying Contractor and listing emergency telephone number(s) at, and outside of, Contractor's field office.

1.04 TEMPORARY UTILITIES

A. General

1. Provide and maintain temporary and interim utility services necessary for performance of Work. Include all costs associated with these services in lump sum price bid.

2. Install and maintain utilities to comply with applicable code, safety, and utility company requirements.

3. Install energy-conserving lighting and programmable HVAC controls in all temporary offices.

4. Contractor shall not use components of the permanent system unless specifically approved by the Owner. Use of permanent utilities or equipment during construction shall not constitute start of warranties or guaranties.

5. Remove temporary utilities after permanent connections have been completed.

6. The Contractor shall be responsible for any damage or injury to equipment, materials, or personnel caused by temporary utility installations.

B. Water

1. Unless otherwise specified, the County will provide all water required for this Contract during the entire construction period at no cost to the Contractor.

2. Water furnished for uses other than testing will be metered only when estimated quantity is greater than 10,000 gallons total.

3. The Contractor shall be responsible for the following:
   a. Making the necessary arrangements for hookup.
   b. Extend branch piping with outlets located so water is available by hoses with threaded connections.
   c. Provide temporary heat taping and pipe insulation to prevent freezing, where necessary.
   d. Providing all piping, backflow devices, and appurtenances required.
   e. Ensuring the availability of adequate drinking water for his work force, and
   f. Providing temporary pumps, tanks, and compressors as necessary to produce the required flows and pressures.

C. Electric

1. Provide separate electric service and lighting to each construction area for the entire construction period.
   a. Locate feeder and branch wiring with area distribution boxes so that power is available through project site by use of power cords.
b. Provide terminations for each voltage supply complete with circuit breakers, disconnect switches and other electrical devices required to protect power supply system.

2. Submit a power supply plan at the preconstruction conference.

3. Provide electric service of sufficient capacity and characteristics to supply the proper current for the various types of construction tools, motors, welding machines, light, heating plant, pumps, and other work required.

4. Provide all necessary temporary wiring, panelboards, outlets, switches, lamps, fuses, controls and accessories.

5. The Contractor shall pay the metered cost of all electricity used.

D. Sanitary Facilities

1. Provide and maintain an adequate number of temporary toilets with proper enclosures for use by employees during construction.

2. Construction personnel shall not use existing Sanitary Facilities at the Broad Creek II Water Treatment Plant.

3. Locate toilets where directed.

4. Provide adequate supplies of toilet paper.

5. Keep toilets clean and comply with all local and State health requirements and sanitary regulations.

6. Unless otherwise indicated, use prefabricated, chemical type toilet facilities.

E. Heat

1. Provide temporary heating whenever and for such periods as heating may be required. Include equipment, installation, fuel and attendance.

2. Conditions requiring heating include, but are not limited to:
   a. Freeze prevention
   b. To provide suitable working conditions,
   c. To ensure progress of the operation within the established scheduled time and
   d. For curing of concrete.

3. Use warm air heat from oil- or gas-fired portable units heaters suitably located as required for protection of health property.
   a. Heaters whose products of combustion are emitted within heated space shall be used only as approved by Engineer.
   b. Open salamander type heaters will not be permitted

4. If allowed by the Engineer, verify that permanent installation is approved for operation, and that filters are in place prior to use temporary heating.

5. Maintain minimum temperature of 50 degrees F (10 degrees C) in areas where construction is in progress, unless indicated otherwise in specifications or unless otherwise required to protect the construction.

F. Ventilation

1. Ventilate enclosed areas to assist cure of materials, to dissipate humidity, and to prevent accumulation of dust, fumes, vapors, or gases.
2. The Contractor may utilize existing ventilation equipment, if allowed by the Engineer. Supplement equipment with temporary fan units as required to maintain clean air for construction operations.

G. Telephone Service
1. Provide telephones in the Contractor’s field offices at the site.
2. Subcontractors and others performing work or furnishing services at the site shall be permitted to use the Contractor’s telephone without charge for toll-free calls pertaining to the Work.

H. Pumping
1. Provide all temporary pumping necessary to meet contract requirements.

I. Fire Protection
1. Provide temporary fire protection equipment for protection of personal and property during Work.
2. Remove debris and flammable materials daily to minimize potential hazards.

1.05 PROJECT SIGN
A. The County will furnish a metal sign approximately 18-inches by 24-inches in size.
B. The Contractor shall install the sign at a location designated by the Engineer. The Contractor shall also provide the following material:
   1. 4-inches by 4-inches by 8 feet pressure-treated post and a piece of 3/4-inch exterior plywood the same size as the metal sign.
      a. Set the post approximately three feet in ground.
      b. Firmly attach the plywood to the top of the post.
   2. Approximately 12 stainless steel wood screws, minimum #10 5/8 inch long with washers. Use to attach sign and name plates to plywood.
C. The Contractor shall provide a sign to direct project deliveries to the appropriate location.

1.06 MAINTENANCE OF TRAFFIC
A. Traffic Flow
   1. Maintain normal through traffic flow.
   2. Submit a “maintenance of traffic plan” for approval to the Engineer at the preconstruction conference.
      a. Maintenance of traffic shall be in accordance with jurisdictional requirements, the Manual on Uniform Traffic Control Devices and specific permit requirements when specified in the Special Conditions.
      b. Safety measures shall be in accordance with Maryland Department of Transportation, State Highway Administration Standard Specifications Section GP- 7.05 and GP-7.06 and applicable jurisdictional requirements.
      c. Access to the site shall be limited to the entrance off Harry S Truman Parkway. The Contractor shall notify all subcontractors, delivery truck personnel, and employees of this limitation.
B. Jurisdictional and Non-Jurisdictional Requirements
1. Comply with all jurisdictional requirements and be responsible for coordinating operations with the appropriate jurisdictional agencies.

2. In the absence of jurisdictional requirements, roads shall be considered secondary unless otherwise indicated, and the following criteria shall govern:
   a. Provide an employee to whom no other duties are assigned but to direct traffic at all times on roadways that are blocked to any extent by construction equipment or operations.
      (1) This employee shall wear red or orange safety garments and shall be equipped with red flags at least 18 inch square or with signal paddles.
      (2) Provide red lights and reflectorized safety garments during periods of darkness.
   b. On primary roads, do not utilize roadway space for storage of excavated material and other materials.
      (1) Close excavations at the end of each work day by backfilling or by means of steel plates marked in advance with warning signs or other accepted materials, and
      (2) Leave Work area clean and without obstacles during off work hours.
   c. On secondary roads, maintain one-way traffic during working hours.
      (1) Clean up area of the Work site at the end of each workday.
      (2) Provide maximum use of the roadway during off work hours.

3. Temporary Access
   a. Provide temporary facilities as required for pedestrian and vehicular access to properties adjacent to or contiguous with the Project.
   b. Should it be necessary to temporarily interrupt access, notify the Engineer, and after securing the Engineer's approval, notify all affected parties of the time, extent and duration of the interruption.

1.07 TEMPORARY STORAGE AREAS
   A. Use the storage area designated on the drawings to store materials, tools, supplies, equipment, office, and other items necessary for construction.
      1. Comply with Section SP-14.
      2. Alternate, or additional, sites may be used if approved by the Engineer.
      3. Submit plans for all storage areas and structures at the preconstruction conference.
      4. Construct temporary storage yards for products that are not subject to weather damage.
      5. Provide temporary buildings as required to comply with recommendations of equipment manufacturers for stored materials.
         a. Include environmental control systems as necessary.
         b. Arrange or partition the building to provide security and allow access for inspection of stored materials.
c. Store combustible materials such as paints, solvents, fuels, lubricants, etc. in separate facilities. Comply with all applicable health and safety regulations.

B. Maintain an inventory log of all stored materials. Indicate:
1. The material stored,
2. The quantity stored,
3. The location stored, and
4. The date it was stored.

C. The Contractor shall be fully responsible for the security of all storage areas, including fencing, watchmen, or other means.

D. Under no circumstances will the County be responsible for the security of any property belonging to the Contractor, his subcontractors, or any of his work forces.

1.08 HAZARDOUS MATERIAL IDENTIFICATION AND MATERIAL SAFETY

A. Submit a Material Safety Data Sheet (Department of Labor Form OSHA 20), as prescribed in 29CFR 1926, OSHA 2079, Construction Standards and Interpretations, for hazardous material.
1. Provide 5 days before delivery of the material, whether or not listed in Appendix A of the Standard.
2. This obligation applies to materials delivered under this contract which may involve exposure to hazardous materials or items containing these materials.
3. "Hazardous material," as used in this clause, is as defined in 29CFR 1926, in effect on the date of this contract.

B. Comply with applicable Federal, State, and local laws, codes, ordinances, and regulations (including the obtaining of licenses and permits) in connection with hazardous materials.

C. The Owner's rights in data furnished under this contract with respect to hazardous material are as follows:
1. To use, duplicate, and disclose any data to which this clause is applicable.
2. The purposes of this right are to
   a. Apprise personnel of the hazards to which they may be exposed in using, handling, packaging, transporting, or disposing of hazardous materials;
   b. Obtain medical treatment for those affected by the material; and
   c. Have others use, duplicate, and disclose the data for the Owner for these purposes.
   d. To use, duplicate, and disclose data furnished under this clause in precedence over any other clause of this contract providing for rights in data.

D. There may be hazardous materials present at this facility.
1. This notice is to warn and alert Contractor of potentially hazardous materials even though materials may be located outside construction site area or in a restricted area not normally accessible to Contractor or his employees.
2. This does not relieve Contractor of his responsibility for safety of his and his subcontractors' employees.

E. Potentially hazardous materials may also exist at the existing facility and may be supplied as part of this Work.

F. Neither the requirements of this clause nor an act or failure to act by Owner, or Engineer shall relieve Contractor of responsibility or liability for safety of Engineer, Owner, Contractor, and subcontractor personnel and property.

1.09 SECURITY

A. Protect the site, and all work, materials, equipment, and existing facilities thereon, against vandals, and other unauthorized persons.

1. The County shall not be responsible for any loss or damage resulting from any act of an employee, the Contractor, its subcontractors or suppliers, trespasser or other person.

2. The Contractor shall repair all damage to County property resulting from a failure to provide the adequate security. The repairs shall be to the satisfaction of the County.

B. Security shall be at least equal to that provided by the County to protect existing facilities during normal operation. The Contractor's security shall also include such additional security fencing, barricades, lighting, and other measures as required to protect the project site.

1.10 ACCESS ROADS AND PARKING

A. With prior approval by the Engineer, the Contractor may construct, grade, stabilize, and maintain temporary construction roads to various parts of the site as required to complete the project.

1. Provide adequate information to the Engineer on the proposed location prior to constructing any access roads not identified by the Drawings.

2. Orient roads to avoid conflicts with on-going operations, and other construction activities.

3. Obtain any permits or permit modifications required to construct temporary construction roads.

B. Provide and maintain suitable all weather parking areas for the use of all construction workers and others performing services in connection with the project.

1. Personnel shall not park vehicles where they may interfere with public traffic, County operations, or construction activities.

1.11 CLEANING DURING CONSTRUCTION

A. Maintain areas free of waste materials, debris, and rubbish. Maintain site in a clean and orderly condition.

B. Remove debris and rubbish from pipe chases, plenums, attics, crawl spaces, and other closed or remote spaces, prior to enclosing the space.

C. Broom and vacuum clean interior areas prior to start of surface finishing. Continue cleaning to eliminate dust.

D. Remove waste materials, debris, and rubbish from site weekly and dispose of legally off site.
1.12 ENVIRONMENTAL PROTECTION

A. Provide all necessary items to protect the environment while fulfilling the Work described herein. For additional erosion and sediment control requirements, refer to Standard Specifications.

B. Prevention of Water Pollution

1. Conduct all operations as required to avoid contaminating water in adjacent watercourses or water storage areas including wells, whether natural or man-made.

2. Conduct all earthwork, equipment moving, water control in excavations, and other operations likely to create silting so as to minimize pollution of watercourses or water storage areas.

3. Water used during the Contract Work which has become contaminated with oil, bitumens, harmful or objectionable chemicals, sewage or other pollutants shall be disposed of in accordance with local laws and regulations to avoid affecting nearby waters and lands.
   a. Under no circumstances shall the Contractor discharge pollutants into any watercourse or water storage area.
   b. Do not allow water used in aggregate processing, concrete curing, foundation and concrete lift cleanup or any other waste to enter a stream.

C. Noise and Air Pollution Control

1. Conduct operations so as not to violate any applicable ordinances, regulations, rules and laws in effect in the area at the date of bid opening pertaining to noise and air pollution.

2. Conform to all provisions in effect at the date of bid opening as set forth in the following:
   a. Rules and Regulations Governing the Control of Air Pollution in the State of Maryland, COMAR 26.11.01 26.11.21, Maryland Department of Environment as may be amended from time to time;
   b. Rules and Regulations Governing the Control of Noise Pollution in the State of Maryland, COMAR 26.02.03, Maryland Department of the Environment as may be amended from time to time; and

D. Plant Pest Control

1. All soil moving or handling equipment that has operated in or will operate in regulated areas shall be subject to plant quarantine regulations.

2. In general, these regulations require the thorough cleaning of soil from equipment before such equipment is moved from regulated areas to uninfested areas.

3. Complete information may be obtained from the regional office of the Plant Pest Control Division of the United States Department of Agriculture.

E. Preservation of Natural Resources

1. All construction operations, Contract Work, clean up and the condition of the adjacent terrain upon completion of the Work shall fully comply with all applicable regulations and laws concerning the preservation of natural resources.

F. Dust Control
1. Use water sprinklers or chemical dust control binder as may be approved by the Engineer throughout the entire construction period to control dust.

2. Provide dust barriers of cloth, plastic or wood to prevent demolition and construction dust and dirt from entering non-construction areas or contacting existing and installed equipment.

3. If dust barriers are not installed or do not contain the dust in the opinion of the Engineer, the Contractor shall:
   a. Clean up the dust immediately.
   b. Take such other measures as required to contain the dust.

1.13 FLOTATION PROTECTION

A. Protect all below-grade construction to prevent damage or movement as a result of hydrostatic flotation forces encountered during construction. Forces may be due to the presence of storm water, ground water or surface water.

B. Design, furnish, install, maintain, operate, and remove temporary dewatering system(s) required to lower and control ground water, surface water, or storm water to prevent flotation or uplift on structures, portions of structures, tankage, or other installations under construction.

1.14 REMOVAL OF UTILITIES, FACILITIES, AND CONTROLS

A. Remove temporary above grade or buried utilities, equipment, facilities, materials, and controls prior to Substantial Completion inspection.

B. Remove underground installations to a minimum depth of 2 feet. Grade site as shown on the Drawings.

C. Clean and repair damage caused by installation or use of temporary work.

D. Restore existing facilities used during construction to original condition. Restore permanent facilities used during construction to specified condition.

PART 2 PRODUCTS
Not Used

PART 3 EXECUTION
Not Used

END OF SECTION
SECTION 01650
FACILITY TESTING AND START-UP

PART 1 GENERAL

1.01 DESCRIPTION
A. Perform a field testing program for mechanical equipment, systems, processes, digital process control systems, and electrical facilities.
B. Refer to Section 16900 for additional testing requirements of the digital process control system.

1.02 DEFINITIONS
A. System – Integrated operating unit consisting of mechanical and electrical equipment, piping, valves, structures, controls, and instrumentation which operate together to perform a specific function. Mechanical systems are identified in Section 01650.3.02.B. Electrical equipment, piping, valves, structures, controls and instrumentation are not specifically identified in Section 01650.3.02.B but necessary to make the mechanical equipment operate as a unit and considered part of the system.
B. Process Materials – Liquid or chemicals which are conveyed or treated by systems.
C. Plant Water – Water from the existing plant water distribution system. This is potable water.
D. Prerequisites – Items of work or submittals required prior to beginning each test.

1.03 TESTING REQUIREMENTS
A. Testing requirements are as indicated in each specifications section.
B. Items to be tested in accordance with this Section are as follows:
1. Vacuum Pumps
2. Greenleaf Filters
3. Lime System
4. Clearwell Pumps
5. Control System Equipment
6. Standby Generator
7. Variable Frequency Drives (VFDs)

1.04 QUALITY ASSURANCE
A. Preliminary Test
1. The purpose of this phase of tests is to demonstrate that all of the equipment and systems when energized will perform the functions required by the Contract Documents, the approved Contractor’s Drawings, and the preliminary approved Operation and Maintenance Manuals for each item of equipment or system. This phase of tests must demonstrate that the equipment or system has been properly installed, rotates when energized, sequences properly, and activates alarms, as required. Neither fluids nor process materials need to be utilized during this phase of testing. The quality of workmanship and installation will be examined for deficiencies and logged in a punch list of items of work to be completed prior to the Prefinal Test. Specific tasks include (as applicable):
a. Conduct adjustment, testing and calibration of all controls, switches, drives, and other instrumentation and control associated with the piece of equipment.

b. Demonstrate that alignment and clearances are properly adjusted.

c. Demonstrate that the equipment can be started, operated in all local modes, and stopped locally as required.

d. Verify proper operation of hard-wired interlocks.

e. Conduct additional testing required by the manufacturer to verify proper installation of the equipment.

f. When local codes or laws require approval and inspection of the work by other agencies or organizations before installation or operation, such approval shall be obtained. Submit one signed original and three copies of the approval to the Engineer.

g. In accordance with the Construction Schedule and with approval of the Engineer, schedule the Preliminary Tests a minimum of ten days before the Prefinal Tests are scheduled to begin.

h. Tests to be provided by the Contractor and tests to be provided by an Independent Testing Company, shall be performed and recorded prior to the Preliminary Tests in order to avoid delays of the scheduled testing procedures.

B. Prefinal Test

1. The purpose of this phase of tests is to demonstrate that all equipment and systems have been installed in accordance with the Contract Documents, approved Operations and Maintenance Manuals, and the Contractor’s Drawings which have been approved; all integrated equipment and systems operate as complete units; all punch list items developed in the Preliminary Tests have been corrected and the results of this Test shall contribute toward a unanimous, satisfactory recommendation from the Commission Inspection, Operations, and Maintenance personnel that the system is ready for Start-up. Specific tasks include (as applicable):

a. Demonstrate proper operation of the equipment in Local mode under actual or simulated operating conditions for a set period of time. Materials to be used are specified below.

b. Simulate alarm conditions to demonstrate operation of hard-wired interlocks.

c. Check equipment for:

   (1) Overheating
   (2) Excessive vibration
   (3) Excessive noise
   (4) Overcurrent

d. Confirm operation of Emergency Stop / Lockout

e. Demonstrate proper operation of automatic controls, if supplied by the manufacturer.
C. Startup Tests
   1. The purpose of this phase of tests is to demonstrate that the unit process within a system operate together to perform the required functions for an extended period of time, under actual operating conditions, with process liquids and chemicals. In addition, this test will verify that all systems and elements of the Work are fully operational and ready to be turned over to the County.
   2. Deficiencies noted in the Prefinal Tests shall be corrected before starting the Process Systems Demonstration Tests.

D. All inspections and tests shall be in accordance with the latest edition of the applicable test procedures of the following standards associations.
   1. ANSI – American National Standards Institute
   2. IEEE – Institute of Electrical and Electronic Engineers
   3. ICEA – Insulated Cable Engineers Association
   4. NEC – International Electrical Code
   5. NEMA – National Electrical Manufacturer’s Association
   6. NETA – National Electrical Testing Association
   7. AWWA – American Water Works Association

E. Coordinate tests with the data, instruction, and recommendations provided in the Short Circuit Calculations and Coordination Studies specified in Division 16, which studies will have been approved prior to the start of testing.

F. Perform tests, in accordance with manufacturer’s accepted test procedures.

G. Hire an Independent Testing Company to perform tests and submit data as specified herein. Submit the name of the Independent Testing Company for approval by the Engineer prior to testing.

1.05 SUBMITTALS
A. Submit a schedule of dates and times for the performance of the specified phases of testing. Include a description of the items of equipment and systems to be tested, and the testing sequence to be employed.

B. Record Forms
   1. Provide test data record forms for each system and item of equipment tested. Submit the form and format of the forms for approval. Completed test forms must contain the following minimum identifications, data, and quality.
      a. Project identification.
      b. Test stage identification, Preliminary or Prefinal.
      c. Sequence number of the test, i.e., First Test, Second Test…Final Test.
      d. Date test was begun, and date when completed.
      e. Identification of testing facility, e.g., Contractor, Independent Testing Co., Manufacturer.
      f. All data must be typewritten or neatly hand lettered, not long hand, and must be clear and bold enough to permit photocopying without loss of clarity.
      g. Include on all test data record forms, or the Title Sheet of a multiple page test report the signature of the person conducting the tests or the chief
person of a test team. Signatures shall be augmented by typewritten or hand-lettered facsimiles.

1.06 TEST EQUIPMENT

A. The Contractor, Independent Testing company, and, where required, the manufacturers field service personnel are responsible for providing all test instruments, gauges, meters and auxiliary equipment. Test and calibrate all test equipment no more than 6 months prior to their use on this contract.

PART 2 PRODUCTS – Not Used

PART 3 EXECUTION

3.01 PREREQUISITE ACTIVITIES

A. Unless specified otherwise, perform the following prerequisite items of work, prior to beginning Preliminary Tests:
   1. Deliver preliminary Operations and Maintenance Manuals to the Engineer in accordance with SP-10.
   2. Verify that there is no visible corrosion or mechanical damage to the equipment.
   3. Verify that name plates for equipment have correct legends.
   4. Verify that all mountings are secure and level, all piping attached, all belts and drives are installed and tensioned correctly, and all safety features are in place.
   5. Verify that all control and power circuits to the equipment are energized.
   6. Bump motors to verify correct rotation. Test motors in accordance with Section 16220.
   7. Perform megger tests on all motors and electrical equipment.
   8. Perform testing in accordance with Section 16900.3.4.
   9. Verify operation of seal water systems.
  10. Verify operation of valves.
  11. Inspect valving and verify proper open or shut positions
  12. Check all feed and drain lines.
  13. Verify that all equipment has been properly lubricated in accordance with manufacturer requirements.
  14. Other activities as specified in this Section.

B. Unless specified otherwise, perform the following items of work prior to beginning Prefinal Tests:
   1. Correct punchlist items from Preliminary Test.
   2. Submit Manufacturer’s Certificates in accordance with SP-08.
   3. Deliver final, approved Operations and Maintenance Manuals to the Engineer in accordance with SP-10.
   4. Perform testing in accordance with Section 16900.3.04.
   5. Other activities as specified in this Section.

C. Unless specified otherwise, perform the following items of work prior to beginning the Start-up Tests:
   1. Correct punchlist items from Prefinal Test.
2. Verify that adequate chemicals and/or process liquids are in place for the respective equipment and systems.

3. Verify that equipment, piping, tanks, sumps, or wet wells do not leak when filled with clear potable water. Leakage tests shall be performed in accordance with Sections 03300, and 15075.

4. Complete all final testing required in Divisions 2 and 11 through 16.

5. Other activities as specified in this Section.

6. Complete all training activities required for each system, facility, and equipment.

7. Complete all Digital Process Control System testing including demonstration of remote/auto programs for all systems and processes.

8. Make all necessary corrections to mechanical equipment to eliminate excessive vibration.

3.02 START-UP TESTING

A. Certain systems will be completed prior to others and will need to successfully proceed through start-up and testing for the plant to continue treating the necessary quantities of water. The sequence of testing will be dictated by the Contractor’s construction schedule and use of temporary facilities. The constraints listed in SP-06 govern at all times.

B. All equipment, piping, structures, and facilities associated with the systems identified above shall satisfactorily complete Prefinal testing. Correct all associated deficiencies before beginning Start-up testing.

C. The Contractor is responsible for all labor, materials (liquids, chemicals, etc.), power, and utilities throughout the Start-up Test. During these tests, the County’s personnel will operate all valves and equipment under the direction of the Contractor.

D. The Start-up Tests include coordinated operations of the facilities by the Contractor, County, and the Manufacturers for equipment items and systems. Start-up Tests will only be completed after all required functional tests and those tests deemed necessary for the safe operation of the system have been completed. Provide onsite qualified staff for the entire duration of the tests.

E. Test multiple and redundant equipment, tanks, process trains, pumps, etc. individually at each and every level of tests.

F. See SP-06 for additional requirements and sequencing of work.

3.03 ACCEPTANCE OF THE WORK AND SPECIFIC TESTS

A. The Engineer will issue Conditional Acceptance for each piece of equipment, system, and process after successful completion of all testing and the equipment, system, and process must be put into service in order for the Work to proceed. In accordance with GP-5.12 the contract guarantee period will begin on the day of Conditional Acceptance. No interim conditional acceptance payments will be made.

B. Final Acceptance of the Work will occur as described in GP-5.

C. Specific Elements of Preliminary and Prefinal Tests

1. The testing requirements are in addition to the requirements given above and in the individual specification sections and are not all inclusive. Additional testing requirements may be requested by the Engineer or manufacturer.
PART 1 GENERAL
1.01 DESCRIPTION
A. Comply with this section of the specifications to close out the Work. Items addressed include but are not necessarily limited to the following:
   1. Cleanup.
   2. Restabilization and Restoration.
   3. Protection of Work in place.
   4. Removal of construction items.
   5. Contract completion requirements
B. Submit separate agreements with adjacent property owners for clean up and site work, if applicable, to the Engineer for approval before beginning work.
   1. Site work includes grading, seeding, sodding; and tree repair, removal or replacement.
   2. Comply with County Standard Specification Sections 02830 and 02860.

PART 2 PRODUCTS
Not Used

PART 3 EXECUTION
3.01 CLEANUP
A. Clean the area as construction progresses. Clean shall include but is not limited to:
   1. Removal of all mud, oil, grease, soil, gravel, trash, scrap, debris, and excess materials that are unsightly or that create a safety hazard for workmen.
   2. Remove water from floor areas where electrical power tools are to be used and to prevent stains on concrete that will be exposed in the finish work.
   3. Use cleaning materials and equipment with care to avoid scratching, marring, defacing, staining, or discoloring the surfaces cleaned.
B. Perform final cleanup immediately prior to requesting final inspection of the Project or any portion thereof.
C. Clean all exposed areas "Broom Clean". In addition, exposed surfaces constructed of the following materials shall be cleaned as listed herein:
   1. Glass: Wash and polish
   2. Painted Surfaces: Remove marks, stains, fingerprints, and dirt.
   3. Exposed Slabs: Wash, scrape, and scrub, using a detergent as necessary to remove bond breaker, dirt and discolorations.
   4. Asphalt Paving: Remove mud, dirt, and trash and hose down until clean.
   5. Aluminum: Clean as directed by the manufacturer.
   6. Other Surfaces: Remove all blemishes, and leave the surface clean, uniform, and dust free.
7. Premises and Site: Remove all trash, debris, surplus excavated material and similar items.

D. Remove all material not part of the Work from the project site.
   1. Do not dispose of any item on County’s property
   2. Items and excess materials that are to be discarded shall be deposited in authorized public landfills.

3.02 RESTORATION AND RESTABILIZATION

A. This Work applies to all disturbed areas including but not limited to staging and stockpiling areas, construction strips, access roads, stream crossings and areas within the acquired right of way.

B. Comply with the requirements set forth in Sections Division 2. This shall include seeding, sodding and paving when season allows.
   1. Disassemble and remove all temporary facilities provided by the Contractor.
   2. Leave the site in an orderly and restored condition as required by the Contract Documents.

C. Preserve public and private signs, markers, guard rails and fences.
   1. Maintain them in their existing locations and condition unless written permission is obtained for their removal, restoration, or replacement.
   2. Remove such conflicting facilities when grading operations begin and store in a manner to keep them clean and in their existing condition.
   3. Restore items to their original locations or a new location as directed by the Engineer.
   4. Repair or replace damaged items when directed, at no cost to the County.

D. Restabilize turf areas as specified in County Standard Specification Section 02820.

E. Protect, repair, and replace trees as specified in Section 02860, if applicable.

F. Restore gravel surfaces and roadway shoulders as near as practicable to their condition prior to being disturbed.
   1. Do not reuse shoulder material if contaminated by foreign material. In such cases, replace with new material of same quality and gradation.
   2. Comply with jurisdictional requirements and with applicable permits secured for this Contract.
   3. Stabilize areas adjacent to shoulders with gravel or other acceptable material, if left unstable by construction activities.

G. Restore pavement, curbs, other paved areas and sidewalks as specified elsewhere in these Contract Documents.

3.03 DISPOSAL OF WASTE AND EXCESS MATERIALS

A. Dispose of construction waste and excess materials in an authorized County disposal area or in an area covered by a current grading or sediment control permit.
   1. Furnish three copies of grading permits to the Engineer prior to using the disposal site.

B. If waste and excess material is disposed of in an unauthorized area; it shall be removed by the Contractor.
1. Restore the area as near as practicable to its condition before disturbance.

2. Perform this Work at no cost to the County.

C. Dispose of human waste in the special sites designated therefore.

3.04 REMOVAL OF CONDEMNED MATERIAL

A. Remove material delivered to the Contract site which is determined by the Engineer to be unsuitable or not in accordance with the Contract Documents from the Work site. Dispose of this material in an approved area.

END OF SECTION
SECTION 02050
SELECTIVE DEMOLITION

PART 1 GENERAL

1.01 DESCRIPTION

A. Demolish and remove structures, equipment and appurtenances to the limits shown on the Drawings and as required to accommodate new construction.
   1. Salvage specified items and materials.
   2. Remove and properly dispose of resulting rubbish and debris.
   3. Clean interior and exterior of finished water reservoirs

B. Demolition Work includes but is not limited to select portions of the facilities at:
   1. Treatment Building
   2. Clarifier building
   3. Filter building
   4. Residuals clarifier
   5. Various Underground Utilities

1.02 GENERAL REQUIREMENTS

A. Site Visit
   1. Review Contract Documents to identify specific items to be removed.
   2. Inspect existing facilities prior to bid to become familiar with the existing installations, level of complexity at each, and the actual extent of required demolition.
   3. Obtain all information necessary to develop a bid for “Demolition Work”.

B. Existing Operations
   1. Coordinate demolition Work within the operating facility with plant operations personnel.
      a. Minimize disruptions to facility operations.
      b. Avoid interferences with operations personnel.
   2. Coordinate disruptions to utility services with the appropriate utility and the Engineer.

C. Unless otherwise specified, materials resulting from demolition Work shall be considered rubbish and debris.
   1. Remove rubbish and debris from the site daily unless otherwise directed by the Engineer.
   2. Store those items which cannot practicably be removed daily as directed by the Engineer.

D. Disconnect and deactivate all mechanical and electrical services prior to beginning demolition Work.
   1. Cap, or re-route and reconnect piping and electrical services that are to remain so as to not interfere with construction activities or operation of the existing facility.
E. Provide warning signs, barricades and safety barriers to protect personnel.
F. Provide fire safety measures wherever burning torches are used.

1.03 SUBMITTALS
A. Comply with Section SP-09.
B. Submit a demolition work plan for each area requiring demolition. Address the following:
   1. Procedures for accomplishing the Work. Describe the methods and equipment that will be used for each operation.
   2. Safety.
   3. Removal and disposition of items to be salvaged.
   4. Protection of property and equipment which are to remain.
   5. Coordination with other Work.
   6. Coordination with existing plant operations.
   7. Procedures for disconnecting utilities.
   8. Work sequencing.
   9. Dust control.
   10. Disposal of rubbish and debris. Identify where the material will be deposited and provide a permit for disposal, if required.
C. Inspect each existing facility prior to demolition as required by General Provisions.
   1. Submit an inspection report.
   2. Identify items to be salvaged and equipment that will remain after demolition.

1.04 SALVAGED ITEMS
A. The following items shall be salvaged:
   1. West Rapid Mix Building
      a. Water Champ and related VFD
      b. Lubricant Scale
      c. All electrical panels
      d. Analytical instruments in chemical feed area
   2. West Flocculation Area
      a. All grating
   3. East Rapid Mix
      a. Lubricant Scale
      b. All electrical panels
      c. Analytical instruments in the chemical feed area
   4. East Flocculation Area
      a. All grating
   5. East Storage Building
      a. All contents
6. **PACI Feed Room**
   a. Flow control valves
   b. Magnetic flow meters
7. **Polymer feed area**
   a. Polymer feed pumps
8. **Chlorination Buildings**
   a. All chlorinators
   b. All injectors
9. **Finished Water Reservoirs**
   a. Sample Pumps

B. **Clean, remove, protect, tag/identify and deliver each of these items to the location designated by the Engineer.**
   1. Unless otherwise noted, deliver the items to the E&M Building adjacent to the Solids Facility.
   2. Handle all salvaged items to prevent damage.
   3. Repair items damaged due to the Contractor’s negligence or carelessness during demolition at no cost to the County.
   4. Classify items which cannot be repaired as construction debris and dispose of them accordingly.

1.05 **PROTECTION**

A. Provide scaffolding, protective coverings, temporary walks, shoring and bracing during demolition to protect personnel, structures and equipment.
   1. Ensure structural elements are not overloaded as a result of demolition.
   2. Support or reinforce existing construction that is weakened by demolition.

B. **Provide adequate lighting at all times during demolition operations.**

C. **Provide and maintain barriers of cloth, plastic or wood to prevent debris and dust associated with the demolition work from leaving the demolition area.**

D. **Provide protective devices as well as dust and debris covers for mechanical and electrical equipment within the demolition area that will remain in-place or be salvaged.**

E. **Protect the Work, including the following, from damage due to weather:**
   1. Building interiors
   2. Equipment to remain
   3. Salvageable equipment and materials

F. **Provide warning signs as required, for personnel and the public.**

G. **Protect and maintain bench marks and survey control points during construction.**

**PART 2 PRODUCTS**

Not Used
PART 3 EXECUTION

3.01 PRE-DEMOLITION INSPECTIONS

A. Inspect all existing structures, equipment, paving, and similar items that are adjacent to the demolition area and that will remain in place.
   1. Record defects and damage.
   2. Notify the Engineer of items found.

B. In each area requiring demolition, clearly identify in the field those items that are to be demolished and those items which are to be salvaged.
   1. Schedule a walk-through with the Engineer to verify that the correct Work has been identified.
   2. Resolve discrepancies and problem areas with the Engineer prior to proceeding.

3.02 CLEANING OF THE FINISHED WATER RESERVOIRS

A. The Contractor shall clean the interior of each Finished Water Reservoir prior to conducting the pre-demolition inspection.
   1. Schedule the draining of each reservoir with the plant staff. Plant staff will drain each reservoir.
   2. Remove lime mud build up from the walls and floors. Assume an average of 3-inches of lime sediment over the entire area of the reservoirs. This assumption is for determining total quantities only. Various areas within the reservoir may have more or less lime sediment.
   3. Pressure wash interior and exterior concrete surfaces that are to remain and that will be modified or rehabilitated.

B. Clean all surfaces such that they are suitable for the subsequent Work.

3.03 DEMOLITION

A. Perform so as to not damage adjacent structures, equipment, paving and materials which are to remain.
   1. Do not use explosives.
   2. Repair or replace damage resulting from demolition activities as directed by the Engineer.
   3. Replace existing utilities damaged by demolition activities with the same quality material as the existing utilities.

B. Saw cut concrete paving to be removed.
   1. Cut along limiting lines to a depth at least one-half the slab thickness.
   2. Minimize damage to the concrete that is to remain.

C. When existing concrete is to be removed and new concrete is to be extended from the edge, maintain sufficient projecting reinforcing to develop a lap splice.

D. Remove the following with equipment unless directed otherwise:
   1. Equipment pads. Cut off existing anchor bolts flush with the surface and seal with epoxy grout.
   2. Piping and Valves.
   3. Pipe hangers and supports.
4. Conduit and wiring
5. Hardware and accessories.

E. Remove conduit and wiring associated with demolished equipment back to the source if it is not being reused.
   1. Remove embedded conduit to slab, cut flush with slab and fill with grout.
   2. Disconnect wiring at source unless the source is being demolished.

F. When piping or valves are removed from an operational system, provide caps, plugs, or blind flanges, as appropriate, to seal the connecting point.

G. Do not dispose of refuse and debris by burning on-site.

H. Wet down areas being demolished as necessary to control dust.

3.04 CLEANUP

A. Broom clean the work area at the end of each working day.
   1. Remove waste, litter, and debris daily.
   2. Place in dumpster type containers.

B. Locate dumpster type containers at convenient locations throughout the site, as approved by the Engineer.
   1. Empty containers at least once weekly or when the containers are full, whichever occurs first.
      a. Remove from the project site and conform to laws and regulations regarding hauling and disposal.
      b. Transport so as to avoid spillage or streets or adjacent areas.
   2. Keep area around containers clean. Pick up spillage as soon as it occurs.

C. Remove protective devices and dust covers when demolition is complete. Remove dust that may have passed dust covers.

3.05 FIELD QUALITY CONTROL

A. Engineer shall visually inspect demolition and adjacent areas for the following:
   1. Completeness of demolition,
   2. Damage that may have resulted from the demolition operation and
   3. Completeness of clean-up.

B. New construction shall not begin until the inspection by the Engineer is completed and accepted.

END OF SECTION
SECTION 02676
TESTING AND DISINFECTION

PART 1 GENERAL

1.01 DESCRIPTION
A. This Work includes the cleaning, flushing, testing and disinfection of all new structures downstream of the filter influent. This includes but is not necessarily limited to the following:
   1. Filters
   2. Filter clearwell
   3. Filter and finished water piping
B. Related Work specified elsewhere
   1. Cast- In place Concrete – Section 03300.

1.02 QUALITY ASSURANCE
A. Comply with applicable standards including, but not limited to the most recent edition of the following:
   1. American Water Works Association (AWWA)
      a. Hypochlorites – AWWA B300
      b. Liquid Chlorine – AWWA B301
      c. Disinfection of Water Storage Facilities – AWWA C652
      d. Disinfection of Water Treatment Plants – AWWA C653
B. Safety
   1. If liquid chlorine is the selected disinfectant, use personnel knowledgeable of the hazards involved and trained in handling the types of emergencies that can arise with the equipment involved.
   2. Provide adequate ventilation inside tanks and enclosures.
   3. Provide personnel with the appropriate protective clothing and equipment.

1.03 SUBMITTALS
A. Comply with Section SP-09.
B. Identify proposed cleaning agents, including their chemical make-up. Certify that agents are safe and approved by AWWA for use in potable water supplies.
C. Submit structure testing disinfection plan. Include the following:
   1. Schedule
   2. Plan for obtaining and conveying water to the structure.
   3. Proposed disinfectant for each structure and piping and method for applying that disinfectant.
   4. Plan for dechlorinating (if necessary) and disposition of the water when disinfection and testing is complete.
   5. Method of re-disinfection, if it should be necessary.
PART 2 PRODUCTS

2.01 CLEANING AGENTS

A. Select to be certified by AWWA for use in a potable water supply.
B. Do not use any substance that would violate water quality health-effects standards if introduced into the water supply during disinfection and filling operations.

2.02 DISINFECTING AGENTS

A. Liquid Chlorine
   1. Comply with AWWA B301
   2. Only use in conjunction with the appropriate gas chlorinators and injector systems.
   3. Use a knowledgeable and experienced technician to supervise operation of the chlorination system.
   4. Observe all accepted safety practices.
B. Sodium Hypochlorite and Calcium Hypochlorite
   1. Comply with AWWA B300.
   2. Store in approved containers.
   3. Observe all accepted safety practices.
   4. Plant’s existing sodium hypochlorite systems may be used for disinfection.

PART 3 EXECUTION

3.01 GENERAL

A. County will furnish potable water for testing and disinfection.
   1. The Contractor will be required to convey all water provided from the source identified by the County to the point of use.
   2. The quantity of water available to the Contractor and the rate that it may be obtained at any time will depend on County water demands.
      a. Schedule all water requirements at least 10 working days in advance.
      b. Water delivery will be curtailed or delayed if necessary to meet distribution system demands. This will not be considered as cause for delay.
B. Disinfect piping and structures just prior to placing them into service to minimize the possibility of recontamination.
C. Leakage testing and disinfection of structures may be performed simultaneously.
D. Apply all interior coatings and finishes prior to disinfection.

3.02 CLEANING

A. Thoroughly clean all structures and pipelines prior to cleaning or disinfection. Cleaning is required per AWWA C652 even if the structure does not need to be disinfected (i.e. prior to filtration).
B. Remove all items that do not remain as part of the permanent facility.
C. Sweep facilities to remove as much dirt, debris, and foreign material as possible.
D. Use a high pressure hose to thoroughly wash down all surfaces. Size the nozzle to deliver a minimum flow rate of 50 gpm.
   1. Remove all water, dirt and foreign material using the tank drains.
   2. Coordinate the destination of the drainage with the plant staff.
   3. Contractor shall be responsible for cleaning drains that have been overloaded with construction debris.

3.03 LEAKAGE TESTING
   A. Perform as specified in Section 03300.

3.04 DISINFECTION
   A. Disinfect piping as specified in Standard Specifications Section 02551.
   B. Disinfect the specified hydraulic structures in accordance with AWWA C652.
      1. Use Chlorination Method Number 3.
      2. Maintain residual after filling the tankage to its maximum operating level at approximately 4 mg/L. If less than this value, drain water from the facility and add sufficient chlorinated potable water to bring the residual to the prescribed value.
   C. After the prescribed contact time, County will collect samples and test the water to ensure it is safe for consumption.
      1. Test for coliforms in accordance with “Standard Methods for the Examination of Water and Wastewater”. Also test for odor.
      2. If the coliform test is negative and offensive odors are not present, place the basin in service.
      3. If any of the coliform samples are positive:
         a. Take repeat samples at least 24 hours apart until consecutive samples are negative.
         b. Repeat the disinfection procedure and re-test.
      4. If odors are present and the water is deemed by the plant staff to be unsuitable for distribution:
         a. Discharge water to sewer.
      5. Do not discharge chlorinated water to the storm drain system under any conditions.

END OF SECTION
PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:
   1. Formwork requirements for concrete construction.

1.02 QUALITY ASSURANCE

A. Referenced Standards:
   1. American Concrete Institute (ACI):
      a. 116R, Cement and Concrete Terminology.
      b. 318, Building Code Requirements for Structural Concrete.
      c. 347R, Recommended Practice for Concrete Formwork.
   2. Building Code: Maryland Statewide Building Code, the latest Edition including local amendments referred to herein as Building Code.

B. Qualifications:
   1. Formwork, shoring and reshoring (as applicable) to be designed by a professional structural engineer currently registered in the state where the Project is located and having minimum of 3 years of experience in this type of design work.

C. Design Requirements:
   1. Design and engineering of formwork, shoring and reshoring as well as its construction is the responsibility of the Contractor.
   2. Design formwork for loads, lateral pressures and allowable stresses outlined in ACI 347R and for design considerations, wind loads, allowable stresses and other applicable requirements of the controlling local building code. Where conflicts occur between the above two standards, the more stringent requirements shall govern.
   3. Design formwork to limit maximum deflection of form facing materials reflected in concrete surfaces exposed to view to 1/240 of span between structural members.
   4. Minimize the size of form ties and carefully select spacing to minimize potential for development of shrinkage induced cracks.

D. Formwork Removal:
   1. The removal of formwork for columns, walls, and suspended beams, shall comply with ACI 318 and ACI 347R.
   2. Develop a procedure and schedule for removal of shores and installation of reshores and for calculating the loads transferred to the structure during this process.
      a. Perform structural calculations as required to prove that all portions of the structure in combination with remaining forming and shoring system has sufficient strength to safely support its own weight plus the loads placed thereon.
b. When developing procedure, schedule, and structural calculations, consider the following at each stage of construction.

(1) The structural system that exists.
(2) Effects of all loads during construction.
(3) Strength of concrete.
(4) The influence of deformations of the structure and shoring system on the distribution of dead loads and construction loads.
(5) The strength and spacing of shores and shoring systems used, as well as the method of shoring, bracing, shore removal, and reshoring, including the minimum time intervals between the various operations.
(6) Any other loading or condition that affects the safety of serviceability of the structure during construction.

1.03 DEFINITIONS
A. Words and terms used in these Specifications are defined ACI 116R.

1.04 SUBMITTALS
A. Shop Drawings:
   1. Submit shop drawings in accordance with SP-09.
   2. Product technical data including:
      a. Acknowledgement that products submitted meet requirements of standards referenced.
      b. Manufacturer's installation instructions.
      c. Manufacturer and type of proposed form materials.
      d. Manufacturer and type of proposed form ties.
      e. Manufacturer and type of proposed form coating material.
      f. Manufacturer and type of void forms including compressive strength.
   3. Formwork and shoring removal procedure and schedule incorporating impact of mix designs and ambient conditions to be expected; reference Quality Assurance paragraph.
   4. If requested, submit structural analysis and concrete strength data used in planning and implementing form removal and shoring.
   5. Formwork designer qualifications for all formwork supporting elevated concrete construction, including walls and columns over 15 FT tall and elevated slabs and floor systems.

PART 2 PRODUCTS
2.01 MATERIALS
A. Forms for Surfaces Exposed to View:
   1. Void forms:
      a. SureVoid Products, Inc.
      b. Deslauriers, Inc.
      c. Or approved equal.
2. Wood forms:
   a. New 5/8 or 3/4 IN 5-ply structural plywood of concrete form grade.
   b. Built-in-place or prefabricated type panel.
   c. 4 x 8 FT sheets for built-in-place type except where small pieces will cover entire area.
   d. When approved, plywood may be reused.

3. Metal forms:
   a. Metal forms excluding aluminum may be used.
   b. Forms to be tight to prevent leakage, free of rust and straight without dents to provide members of uniform thickness.

B. Forms for Surfaces Not Exposed to View:
1. Wood or metal sufficiently tight to prevent leakage. Do not use aluminum forms where the aluminum will be in contact with fresh concrete.

C. Lumber: Straight, uniform width and thickness; and free from knots, offsets, holes, dents, and other surface defects.

D. Chamfer Strips: Clear white pine, surface against concrete planed.

E. Form Release: Nonstaining and shall not prevent bonding of future finishes to concrete surface.

2.02 ACCESSORIES

A. Form Ties:
2. Constructed so that ends or end fasteners can be removed without causing spalling at surfaces of the concrete.
3. 3/4 IN minimum to 1 IN maximum diameter cones on both ends.
4. Embedded portion of ties to be not less than 1-1/2 IN from face of concrete after ends have been removed.
5. Provide ties with built-in waterstops in all walls that will be in contact with:
   b. Exterior below grade walls of all structures.
6. Through-wall ties designed to be entirely removed are not allowed in any wall that is required to be watertight.
   a. Taper ties shall not be used for concrete construction required to be watertight.

B. Void Forms:
1. Continuous void forms.
2. Specially designed and manufactured for the purpose of creating a void area directly under concrete members which will allow a space for soil vertical upward movement.
3. Able to support the weight of concrete and construction loads to be placed thereon with no decrease in required void form depth.
4. Constructed from double faced corrugated cardboard or fiberboard which is wax impregnated and laminated with moisture-resistant adhesive.
5. Capable of resisting moisture with no loss of load carrying strength or change in depth or configuration.

PART 3 EXECUTION

3.01 PREPARATION

A. Form Surface Treatment:
1. Before placing of either reinforcing steel or concrete, cover surfaces of forms with an approved coating material that will effectively prevent absorption of moisture and prevent bond with concrete, will not stain concrete or prevent bonding of future finishes. A field applied form release agent or sealer of approved type or a factory applied nonabsorptive liner may be used.
2. For water holding structures, provide form oil which will not be toxic after 30 days after application.
3. Do not allow excess form coating material to stand in puddles in forms nor in contact with hardened concrete against which fresh concrete is to be placed.

B. Provide temporary openings at base of column and wall forms and at other points where necessary to facilitate cleaning and observation immediately before concrete is placed, and to limit height of free fall of concrete to prevent aggregate segregation. Temporary openings to limit height of free fall of concrete shall be spaced no more than 8 FT apart.

C. Clean surfaces of forms, reinforcing steel and other embedded materials of any accumulated mortar or grout from previous concreting and of all other foreign material before concrete is placed.

3.02 ERECTION

A. Install products in accordance with manufacturer's instructions.

B. Tolerances:
1. Variation from plumb:
   a. In lines and surfaces of columns, piers, walls, and in risers.
      (1) Maximum in any 10 FT of height: 1/4 IN.
      (2) Maximum for entire height: 1/2 IN.
   b. For exposed corner columns, control-joint grooves, and other exposed to view lines:
      (1) Maximum in any 20 FT length: 1/4 IN.
      (2) Maximum for entire length: 1/2 IN.
2. Variation from level or from grades specified:
   a. In slab soffits, ceilings, beam soffits and in arises, measured before removal of supporting shores.
      (1) Maximum in any 10 FT of length: 1/4 IN.
      (2) Maximum in any bay or in any 20 FT length: 3/8 IN.
      (3) Maximum for entire length: 3/4 IN.
   b. In exposed lintels, sills, parapets, horizontal grooves, and other exposed to view lines:
(1) Maximum in any bay or in 20 FT length: 1/4 IN.
(2) Maximum for entire length: 1/2 IN.

3. Variation of linear structure lines from established position in plan and related position of columns, walls, and partitions:
   a. Maximum in any bay: 1/2 IN.
   b. Maximum in any 20 FT of length: 1/2 IN.
   c. Maximum for entire length: 1 IN.

4. Variation in sizes and location of sleeves, floor openings, and wall openings: Maximum of +1/2 IN.

5. Variation in horizontal plan location of beam, column and wall centerlines from required location: Maximum of +1/2 IN.

6. Variation in cross sectional dimensions of columns and beams and in thickness of slabs and walls: Maximum of -1/4 IN, +1/2 IN.

7. Footings and foundations:
   a. Variations in concrete dimensions in plan: -1/2 IN, +2 IN.
   b. Misplacement or eccentricity:
      (1) 2 percent of footing width in direction of misplacement but not more than 2 IN.
   c. Thickness:
      (1) Decrease in specified thickness: 5 percent.
      (2) Increase in specified thickness: No limit except that which may interfere with other construction.

8. Variation in steps:
   a. In a flight of stairs:
      (1) Rise: +1/8 IN.
      (2) Tread: +1/4 IN.
   b. In consecutive steps:
      (1) Rise: +1/16 IN.
      (2) Tread: +1/8 IN.

9. Establish and maintain in an undisturbed condition and until final completion and acceptance of Project, sufficient control points and bench marks to be used for reference purposes to check tolerances.

10. Regardless of tolerances listed allow no portion of structure to extend beyond legal boundary of Project.

11. To maintain specified tolerances, camber formwork as required to compensate for anticipated deflections in formwork prior to hardening of concrete.

12. Where specific, more restrictive tolerances are called out on the Drawings, these specific tolerances shall govern.

C. Make forms sufficiently tight to prevent loss of mortar from concrete.

D. Place 3/4 IN chamfer strips in permanently exposed to view edges and corners of forms to produce 3/4 IN wide beveled edges.
E. At construction joints, overlap contact surface of form sheathing for flush surfaces exposed to view over hardened concrete in previous placement by at least 1 IN. Hold forms against hardened concrete to prevent offsets or loss of mortar at construction joint and to maintain a true surface. Where possible, locate juncture of built-in-place wood or metal forms at architectural lines, contraction joint, or construction joints.

F. Construct wood forms for wall openings to facilitate loosening, if necessary, to counteract swelling.

G. Anchor formwork to shores or other supporting surfaces or members so that movement of any part of formwork system is prevented during concrete placement.

H. Provide runways for moving equipment with struts or legs, supported directly on grade, formwork, or structural member without resting on reinforcing steel.

I. Provide positive means of adjustment (wedges or jacks) of shores and struts and take up all settlement during concrete placing operation. Securely brace forms against lateral deflection. Fasten wedges used for final adjustment of forms prior to concrete placement in position after final check.

J. After void forms are in place and before concrete is placed thereon, cover joints between abutting form sections and cover ends of forms to prevent intrusion of soil, concrete or any other materials.

1. Install void forms in accordance with manufacturer’s instructions.

3.03 REMOVAL OF FORMS

A. No construction loads shall be supported on, nor any shoring removed from, any part of the structure under construction except when that portion of the structure in combination with remaining forming and shoring system has sufficient strength to safely support its weight and loads placed thereon.

B. When required for concrete curing in hot weather, for repair of surface defects, or when finishing is required at an early age, remove forms as soon as concrete has hardened sufficiently to resist damage from removal operations or lack of support. See Paragraph 1.2D for additional requirements.

C. Remove top forms on sloping surfaces of concrete as soon as concrete has attained sufficient stiffness to prevent sagging. Perform any needed repairs or treatment required on such sloping surfaces at once, followed by curing specified in Section 03300.

D. Loosen wood forms for wall openings as soon as this can be accomplished without damage to concrete.

E. Where no reshoring is planned, leave forms and shoring used to support weight of concrete in place until concrete has attained its specified 28-day compressive strength. Where a reshoring procedure is planned, supporting formwork may be removed when concrete has reached the concrete strength required by the formwork designer’s structural calculations.

F. When shores and other vertical supports are so arranged that non-load-carrying form facing material may be removed without loosening or disturbing shores and supports, facing material may be removed when concrete has sufficiently hardened to resist damage from removal.

3.04 RESHORING

A. No construction loads shall be supported on, nor any shoring removed from, any part of the structure under construction except when that portion of the structure in combination with remaining forming and shoring system has sufficient strength to safely support its weight and loads placed thereon.
B. While reshoring is underway, no superimposed dead or live loads shall be permitted on the new construction.

C. During reshoring do not subject concrete in structural members to combined dead and construction loads in excess of loads that structural members can adequately support.

D. Place reshores as soon as practicable after stripping operations are complete but in no case later then end of working day on which stripping occurs.

E. Tighten reshores to carry their required loads without overstressing.

F. Where no reshoring is planned, leave forms and shoring used to support weight of concrete in place until concrete has attained its specified 28-day compressive strength. Where a reshoring procedure is planned, supporting formwork may be removed when concrete has reached the concrete strength required by the formwork designer’s structural calculations.

G. For floors supporting shores under newly placed concrete leave original supporting shores in place or reshore. Reshoring system shall have a capacity sufficient to resist anticipated loads. Locate reshores directly under a shore position above.

END OF SECTION
SECTION 03300  
CAST IN PLACE CONCRETE

PART 1 GENERAL

1.01 DESCRIPTION

A. Delete Standard Specification Section 03300 in its entirety. Replace with this section.

B. Provide cast-in-place concrete as indicated on the Drawings and as specified and required. Work includes but is not limited to the following:
   1. Furnishing all materials, labor, equipment, and supplies.
   2. Mixing, placing, testing, finishing, and curing cast in place concrete.

1.02 Related Work Included:

A. Related Sections include but are not necessarily limited to:
   1. Division 0 - Bidding Requirements, Contract Forms, and Conditions of the Contract.
   2. Division 1 - General Requirements.
   3. Section 03100 – Formwork.
   4. Section 03200 – Concrete Reinforcement
   5. Section 03400 – Precast Concrete Utility Structures
   6. Section 03600 – Non-Shrink Grout and Mortars

1.03 QUALITY ASSURANCE

A. Conform to applicable requirements of the International Building Code currently in force unless more stringent requirements are specified or shown on the Drawings.

B. Perform work in accordance with ACI 301, ACI 304, ACI 305R, ACI 306R, ACI 347, and ACI 350. Maintain the latest copy of these and other appropriate documents referred to therein on the project site at all times.
   1. Do not exceed 2-hrs. between batching and complete discharge of concrete.
   2. Use mechanical high-frequency internal vibrators to compact concrete during and immediately after depositing.
      a. Provide sufficient standby equipment to ensure vibration will be continuous.
      b. Only use approved external vibrators for compacting concrete when concrete is inaccessible for adequate compaction by other means.
      c. Vibrate concrete to ensure no movement of reinforcing steel from its final position.
   3. Acquire cement and aggregate from same source for all work.
   4. Do not use excess grout or mortar to lubricate pipelines when pumping concrete. Also do not discharge washout water into the forms.

C. Unless otherwise indicated, use an independent testing agency hired by the Contractor and approved by the County’s project manager or designee to perform all testing. Sampling shall be the Contractor’s responsibility.
D. The County may require additional sampling and testing by an independent testing laboratory to determine that specifications are being met. Such testing shall be the Contractor’s responsibility.

E. Field sampling and testing

1. Sampling and Test Methods
   a. Aggregate
      (1) Sampling: ASTM D75
      (2) Testing: ASTM C33
   b. Cement
      (1) Sampling: ASTM C183
      (2) Testing: ASTM C150
   c. Concrete
      (1) Sampling: ASTM C172
      (2) Slump Test: ASTM C143
      (3) Air Content Test: ASTM C231
      (4) Making and Curing Test Cylinders: ASTM C31

2. Testing Requirements
   a. Inspect, sample, and test cement and aggregate at the batching plant. Comply with referenced standards.
   b. Slump Test: Perform one test on each concrete sample tested for compressive strength.
   c. Air Content: Perform one test on each concrete sample tested for compressive strength.
   d. Compressive Strength Testing
      (1) Prepare at least 8 test cylinders for each concrete sample tested.
         (A) Break 2 test cylinders at an age of 7 days.
         (B) Break 2 test cylinders at an age of 14 days.
         (C) Break 2 test cylinders at an age of 28 days.
         (D) Hold the remaining cylinders in reserve.
      (2) Provide at least the following number of test cylinders:

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<th>Size of Pour (cu. yd.)</th>
<th>No. of Samples</th>
<th>No. of Cylinders</th>
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</tr>
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<td>4 - 100</td>
<td>1</td>
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<td>Class A or B</td>
<td>Over 300</td>
<td>1 per 100 cu. yd. or fraction</td>
<td>8 per 100 cu. yd. or fraction</td>
</tr>
</tbody>
</table>

1.04 SUBMITTALS

A. Contractor may request the Engineer review and approval of modifications to the cast-in-place concrete mix designs to improve performance, efficiency, quality control and quality assurance.

1. Such requests shall be developed by an independent engineering and testing firm specializing in the design, testing and placement of cast-in-place concrete.

2. The engineering and testing firm shall have a minimum of five (5) years of experience in the development and testing of various concrete mix designs to meet requirements for strength, appearance, durability, workability, watertightness, economy, etc.

3. The firm shall also maintain accreditations, certifications and laboratory approvals from at least one of the following:
   a. ACI,
   b. US Army Corps of Engineers,
   c. ASTM,
   d. CSI,
   e. ASCE.

B. Submit Contractor’s Drawings and Shop Drawings in accordance with SP-07:

1. Show reinforcing steel in accordance with ACI 315. Include bar lists and bending diagrams, placement drawings, and special details.

2. Show location, types, and details of joints.

3. Sequence of pours.

4. Working Drawings with calculations showing concrete strength to be attained at the proposed time of removal of formwork, falsework and centering.

5. Provide complete engineering and product data for the following:
   a. Admixtures,
   b. Curing compounds,
   c. Dyes,
   d. Bonding agents,
   e. Hardeners,
   f. Sealers,
   g. Waterstops.
C. Submit certified concrete mix designs for all concrete strengths used.
   1. Include proposed admixtures.
   2. Provide certified laboratory or mill test reports on all aggregate and cement used in the proposed mix.
   3. Provide certified laboratory test reports on the compressive strength of concrete resulting from each mix design.
   4. For record purposes include the following information for each class of concrete:
      a. Minimum dry weights of cement; fine and course aggregates;
      b. Quantity, type and name of admixture; and
      c. Volume of water per cubic yard of concrete that will be used in the mix.

D. Submit certified delivery tickets for all concrete provided. Show at least the following information.
   1. Name and location of batch plant and name of plant inspector.
   2. Ticket number.
   3. Load number and batch number.
   4. Date
   5. Truck number.
   6. Destination including name and location of project.
   7. Concrete type, class (strength), and design mix designation.
   8. Actual quantities of all materials including admixtures and amount of concrete in cubic yards.
   9. Time at which mixer drum was charged with cement.
   10. Amount of free moisture by percentage of permissible mixing water in aggregates, plus maximum amount of mixing water which can be added at job site to obtain specified water/cement ratio.
   11. Blank space for initials of on site receiving party.
   12. Time of arrival of concrete truck on site.
   13. Amount of mix water added on-site.

E. Submit a sample delivery ticket with the concrete mix design. A mix design shall not be approved without the inclusion of a sample delivery ticket from the concrete vendor that includes all the information required by this specification.

F. Submit notarized certificates from Suppliers that each of the materials listed below comply with the Specifications and are of the gradation required for each class of concrete. Submit prior to incorporating materials into the Work. If testing is required, submit mill certificates for each test. Conform to specified ASTM Standards.
   2. Stone Aggregate for Concrete shall comply with the following:
      b. Organic Impurities. ASTM C40. Fine Aggregate Only
c. Soundness.
   (1) ASTM C88.
   (2) Do not exceed 8 percent loss for coarse aggregate and 10 percent loss for fine aggregate after 5 cycles.

d. Abrasion of Concrete Aggregate.
   (1) ASTM C131.
   (2) Do not exceed 10 1/2 percent loss after 100 revolutions and 42 percent loss after 500 revolutions.

e. Deleterious Materials. ASTM C33.

f. Material Finer Than 200 (75um) Sieve.
   (1) ASTM C117.
   (2) Do not exceed 1 percent for gravel, 1.5 percent for crushed aggregate per ASTM C33.

g. Reactivity Potential.
   (1) ASTM C289.
   (2) Ratio of silica released to reduction in alkalinity shall not exceed 1.0.

3. If notarized certificates acceptable to the Engineer are not provided, perform the required tests at Contractor’s expense using an Independent Testing Laboratory.

a. Perform tests for each 250 barrels of cement, in accordance with ASTM C150.
   (1) Determine the tensile strength at 7 days.
   (2) Tag the Cement for identification at location of sampling.

b. Test aggregate before the concrete mix is established and whenever character or source of material is changed.
   (1) Include a sieve analysis to determine conformance with limits of gradation.
   (2) Sample aggregates at source of supply or at the ready mix concrete plant in accordance with ASTM D75.

G. Submit certified test reports for all admixtures submitted for use on the project.

H. Submit a detailed step-by-step QC plan for review and approval by the Engineer for the following items.
   1. All finishing procedures related to exposed concrete.
   2. All proposed curing procedures.

1.05 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Deliver, handle, and store the products in accordance with SP-14.

B. Ship cement to the site of the mixer plant in bulk or in paper or cloth bags, at the option of the Contractor.
   1. Store immediately upon arrival in a dry, weather tight and properly ventilated building or enclosure.
   2. Include adequate provisions to prevent the absorption of moisture.
3. Store in a manner that will permit easy access for inspection and identification of each shipment.

4. Provide separate storage facilities for cement that are approved by the Engineer prior to arrival of the first shipment. Do not use cement that is caked or lumpy.

C. Store sand and coarse aggregates in separate stockpiles at points selected to provide maximum drainage and to prevent the inclusion of any foreign material during rehandling.

1. Construct stockpiles of coarse aggregates in horizontal layers to avoid segregation and breakage.

2. Where concrete volumes require batching of various aggregate sizes, provide a separate stockpile for each size maintained.

3. Do not use the bottom 6 inches of aggregate piles.

D. Deliver primers, bond breaking grout, mastic, epoxy, hardener, curing compound and other materials to ensure uninterrupted progress of Work.

E. Store materials in a manner that will preclude damage and permit ready access for inspection and identification.

PART 2 PRODUCTS

2.01 GENERAL

A. Concrete Classification

1. Use Class A for all reinforced concrete cast in forms for structural beams, slabs, floors, walls, columns, footings, and similar structures within the scope of ACI 318 or ACI 350.

2. Use Class B concrete for items such as pipe cradles, pipe and conduit encasement, bedding, collars thrust blocks and other non-reinforced concrete.

3. If Class is not otherwise identified, provide Class A concrete.

B. Design all Class A cast in place concrete in accordance with applicable requirements of ACI 318 and ACI 350.

C. Strength

1. Proportion mix designs according to the section on Trial Batches of ACI 318, latest edition.

   a. Produce a watertight, durable concrete.

   b. Develop the following minimum compressive strengths at an age of 28 days when sampled, cured, and tested in accordance with the procedures specified in ASTM C31 and C39:

<table>
<thead>
<tr>
<th>Class of Concrete</th>
<th>Age</th>
<th>Average of Three Consecutive Specimens</th>
<th>Minimum of One Specimen</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>28 days</td>
<td>4,500 psi</td>
<td>4,000 psi</td>
</tr>
<tr>
<td>B</td>
<td>28 days</td>
<td>3,000 psi</td>
<td>2,500 psi</td>
</tr>
</tbody>
</table>

2. If the average compressive strength of three consecutive specimens falls below the minimum strength specified above, or if the compressive strength of any
single specimen falls more than 500 psi below the minimum strengths specified above; the Engineer may require the following:

a. Change in mix design for the remaining portion of the work.

b. Additional curing of the affected concrete followed by cores taken in accordance with the latest editions of ASTM C42 and ACI 318, all at the expense of the Contractor.

c. If additional curing does not bring the average compressive strength of three cores taken in the affected area to at least the minimum strength specified, the Engineer may require that the Contractor strengthen the structure by means of additional concrete and steel or he may require that the Contractor replace the affected portions.

d. The cost of all such changes in mix designs and any modifications to or replacement of deficient concrete shall be borne by the Contractor at no additional cost to the Owner.

D. Consistency

1. Make consistency such that concrete can be worked readily into the corners and angles of the forms and around the reinforcement without excessive spading and without permitting the materials to segregate or free water to collect on the surface.

   a. When dropped from the discharge chute, the concrete mass should flatten out at the center and spread out slowly at the edges.

   b. Adjust proportions to secure the lowest water/cement ratio which is consistent with good workability and a plastic cohesive mixture.

2. Provide concrete which is within the following slump range as determined in accordance with ASTM C143.

<table>
<thead>
<tr>
<th>Concrete Use</th>
<th>Slump in Inches</th>
</tr>
</thead>
<tbody>
<tr>
<td>Walls</td>
<td>2½ - 4</td>
</tr>
<tr>
<td>Floors and Slabs</td>
<td>2 – 4</td>
</tr>
<tr>
<td>Beams</td>
<td>2 – 4</td>
</tr>
<tr>
<td>Blocks and Footings</td>
<td>2 – 4</td>
</tr>
</tbody>
</table>

   a. Do not use concrete with a slump greater than 1-inch over the specified maximum.

3. Pumped concrete:

   a. Increase the maximum concrete slump at the suction of the pump by the amount of slump loss in the pumping system up to a maximum of 1 inch above the maximum specified slump.

   b. The amount of slump loss is the difference between slump tests made at both ends of pumping system.

      (1) Limit to a total loss of 1 inch.

      (2) If tests indicate a loss greater than 1 inch, take corrective measures acceptable to the County's representative.
4. For thin sections and construction with limited clearance between reinforcing steel and when placement conditions preclude the use of vibrators, the County’s representative may authorize the use of concrete having a slump of 5 inches.

E. Materials used in concrete shall be limited to those noted in this section of the specification. Alternate material shall be submitted for approval by the Engineer prior to submission of the concrete mix design.

2.02 PORTLAND CEMENT
A. Use standard brand of Domestic Portland cement. Do not change brand of cement during the Work without the written approval of the Engineer.
B. Comply with ASTM C150, Type II.
C. Do not use cement of dark color or resacked, lumpy or partially set cement.
D. Each sack of cement shall contain 94 pounds (net) of cement and the volume of that quantity of cement shall be 1.0 cubic foot.

2.03 AGGREGATE
A. Furnish natural aggregates from approved pits, free from opaline, chert, feldspar, mica, siliceous magnesium limestone, and other deleterious and reactive substances.
B. Comply with ASTM C33.
C. Fine aggregate
   1. Fineness Modulus – 2.4 minimum and 3.0 maximum
   2. Material passing No. 200 sieve – less than 3% (by weight) of the total sample.
   3. Coal and lignite – less than 0.5% (by weight) of the total sample for all concrete.
D. Coarse aggregate
   1. Conform to ASTM C33, Class Designation 3S
   2. Maximum size of aggregate
      a. No larger than one-fifth the narrowest dimension between sides of forms.
      b. Less than three-quarters of the minimum clear spacing between reinforcing bars or between bars and forms.
      c. Limit size to ¾-inch for pumped concrete.

2.04 WATER FOR MIXING AND CURING CONCRETE
A. Use clean, fresh, potable quality water that is free from injurious substances.
B. If water is of questionable quality, meet limits of comparison tests with distilled water in accordance with AASHTO T26.
C. The weight of water shall be considered to be 8.33 pounds per gallon.

2.05 ADMIXTURES
A. Provide an air entraining admixture conforming to ASTM C260 in all concrete.
   1. Manufacturers
      a. W. R. Grace “Darex AEA”
      b. Master Builders “MB-VR”
      c. Sika “AEA 15”
      d. Boral “Boral Air 30”
e. Or equal

B. Plasticizer or Water Reducing Admixture
1. Chloride free
2. Conform to ASTM C494, Type A
3. Manufacturers
   a. W. R. Grace “WRDA 35”
   b. Master Builders “Pozzolith Normal”
   c. Sika “Plastocrete”
   d. Boral “Boral NR”
   e. Or equal

C. Accelerators and Retarders
1. May be used only when authorized in writing by the Engineer.
2. Accelerators
   a. Calcium chloride conforming to ASTM D98
   b. Dispense as a solution
   c. Calcium chloride shall not exceed one percent (by weight) of cement content.
   d. Manufacturers
      (1) W. R. Grace “Daraset”
      (2) Master Builders “Pozzutec 20”
      (3) Sika “Plastocrete 161 FL”
      (4) Boral “Boral can”
      (5) Or equal
3. Retarders
   a. Chloride free
   b. Conform to ASTM C494, Type D
   c. Manufacturers
      (1) W. R. Grace “Daratard-HC”
      (2) Master Builders “MBL-8”
      (3) Sika “Plastiment”
      (4) Boral “Boral HC”
      (5) Or equal

D. High Range Water Reducers and Super Plasticizers
1. May be used only when authorized in writing by the Engineer.
2. Conform to ASTM C494, Type F or G
3. Manufacturers
   a. W. R. Grace “Darucem 19”
b. Master Builders “Pozzolith 440N”
c. Sika “Sikament 300”
d. Boral “Boral SP”
e. Or equal

2.06 WATERSTOPS

A. General
1. Conform to the details shown on the Drawings.
2. Do not use split flange waterstops.
3. Provide manufactured accessories at waterstop intersections.

B. PVC waterstops
1. Conform to Corps of Engineers specification CRD-C-572.
2. Use serrated type
3. Use ribbed waterstop 6-inches wide, 3/8-inches thick, with a 1-inch outside diameter center bulb for expansion joints, unless otherwise shown on drawings.
4. Use ribbed waterstop 6-inches wide, 3/8-inches thick, with no center bulb for construction and contraction joints, unless otherwise shown on drawings.
5. Submit a manufacturer’s certificate or test report by an independent testing laboratory as evidence that waterstop complies with these specifications.
6. Manufacturer
   a. Greenstreak PVC Style No. 717
   b. Greenstreak PVC Style No. 679
   c. Approved equal.
7. All PVC waterstop shall be held in place prior to pouring concrete by an acceptable means. PVC waterstop shall not be manually placed into wet concrete for any reason.

C. Mastic waterstops
1. Use Lockstop Waterstop or approved equal where noted on Drawings.
2. Pre-formed rubber, and accessories shall be manufactured by Greenstreak, Style No. 595 or approved equal.

D. Non-movement construction joints
1. Use Hydrotite Waterstop, Greenstreak Style No. CJ-0725-3K, or approved equal, where noted on the Drawings.

E. Compression Seals
1. Use for expansion or contraction joints in concrete slabs where noted on the Drawings.
2. Use G-Seal by Greenstreak, Style No. 628, or approved equal.

F. Field splices
1. Comply with manufacturers recommendations
2. Heat sealed splices:
2.07 POLYETHYLENE FILM
A. Conform to Product Standard PS 17.
B. Provide minimum material thickness of 6 mils.

2.08 EPOXY BONDING AGENT
A. Epoxy adhesives shall be two-component, 100% solids, 100% reactive.
   1. Suitable for use on dry or damp surfaces.
   2. Provide a one-day compressive strength of not less than 5,000 psi and a 28-day strength of not less than 12,000 psi when cured at a temperature of 73o F. Conduct strength testing in accordance with ASTM D695.
   3. Provide a 28-day tensile strength of not less than 3,500 psi, when tested in accordance with ASTM D638.

B. Manufacturers
   1. Euco Epoxy #463, and #615 by The Euclid Chemical Company
   2. Sikadur 32 Hi-Mod by Sika Chemical Corporation.
   3. Or equal.

2.09 VAPOR BARRIER
A. Provide under all slabs poured on earth, unless otherwise noted.
   1. FHA approved.
      a. Form a moisture, scuff, and puncture resistant membrane.
      b. Provide moisture permeance less than or equal to 0.10 perms per ASTM E96, procedure A.

B. Manufacturer
   1. St. Regis Paper Company “Moistop Ultra 6-Vapor Barrier”
   2. Or equal.

2.10 CURING MATERIALS
A. Use only non staining, clear or translucent curing compounds with a 100 percent resin base meeting requirements of ASTM C309, Type I, Class B.
   1. Add fugitive dye in sufficient amount to produce a definite, distinguishing color.
   2. Select to be compatible with liquid hardeners and epoxy sealers.
   3. Manufacturers
      a. W.R. Meadows Inc." 1100 Clear Series"
      b. Or equal.

B. Sheet materials for curing: Comply with ASTM C171.
C. Burlap cloth made from jute or kenaf for curing shall meet requirements of AASHTO M182, Class 1.
2.11 EXPANSION JOINT FILLER
A. Filler not exposed to traffic or weather: Comply with ASTM D994.
B. Filler exposed to traffic and/or weather: Comply with ASTM D1751 or ASTM D1752.

2.12 TEMPORARY JOINT FILLER
A. Use straight, sound strips of wood of the width and depth indicated on the drawings or as approved.
B. Taper the strips slightly from face to back.
C. Coat with paraffin or the equivalent to seal against moisture and to promote ready removal with forms.
D. Design to produce true, straight joint edges.

2.13 JOINT SEALER
A. Hot applied: Comply with ASTM D1190.
B. Cold applied: Comply with ASTM D1850.

PART 3 EXECUTION
3.01 DESIGN MIXES
A. The Engineer shall approve mix design prior to beginning any concreting operations.
   1. Prepare mix design in accordance with ACI 318 for each class of concrete used.
   2. If mix design is based on trial batches, provide sufficient data to establish a standard deviation. If insufficient data is provided to establish a standard deviation, the mix must produce the following average 28 day compressive strength to be acceptable:
      a. Class A: 1,200 psi greater than specified strength.
      b. Class B: 1,000 psi greater than specified strength.
   3. Include the following information with the mix design:
      a. Fine aggregate (Sample per ASTM D75)
         (1) Source and type
         (2) Sieve analysis – ASTM C136
         (3) Magnesium sulfate soundness – ASTM C88
         (5) Saturated surface dry weight per cubic yard of concrete.
         (6) Bulk specific gravity – ASTM C128
         (7) Fineness modulus – ASTM C136
      b. Coarse aggregate (Sample per ASTM D75)
         (1) Source and type
         (2) Sieve analysis – ASTM C136
         (3) Abrasion loss – ASTM C131
         (4) Magnesium sulfate soundness – ASTM C88
(6) Saturated surface dry weight per cubic yard of concrete.
(7) Bulk specific gravity – ASTM C127

c. Cement (Sample per ASTM C183)
   (1) Manufacturer, type and ASTM designation.
   (2) Pounds per cubic yard of concrete.
   (3) Total gallons of water per sack (cu. ft.) of cement
   (4) Compressive strength at 7 and 28 days – ASTM C109
   (5) Chemical analysis – ASTM C114

d. Slump – ASTM C143

e. Air Content – ASTM C173 or C231

f. Unit Weight – ASTM C138

g. Time to initial set at 70 degrees F – ASTM C403

h. Compressive Strength at 7, 14, and 28 days – ASTM C192 and C39.
   (1) Prepare 9 cylinders for each mix design
   (2) Cure in the laboratory
   (3) Test 3 cylinders at each of 7, 14, and 28 days.

i. Testing laboratory verification of the water cement ratio. Required before mix is approved.

j. Admixtures
   (1) Manufacturer, type, and ASTM designation.
   (2) Certification of chloride content.
   (3) Dosage and point of introduction into the mix.

k. Pozzolans
   (1) Manufacturer, type, and ASTM designation

B. Unless otherwise indicated, use the following specified 28 day compressive strengths of concrete:
   1. 4,500 psi (Class A) for all reinforced structural concrete.
   2. 3,000 psi (Class B) for non-reinforced concrete.
   3. 2,000 psi for mud mats, pipe encasement, filling voids between pipes and casing, limited site voids, soil boring voids, and for under foundations where excavated to excessive depth.

   4. Lean mix concrete for filling abandoned manholes, pipes, and similar items.
      a. Minimum 94 pounds of cement per cubic yard of concrete.
      b. Aggregate no larger than 1 1/2-inch.

C. Mix Proportioning
   1. Design Class A concrete for structures to conform to ACI 301 and the following
a. Provide air entrainment as follows:
   (1) 5±1 percent Coarse Aggregate No. 467
   (2) 6±1 percent Coarse Aggregate No. 57 or 67
2. Proportion all other concrete mixes in accordance with ACI 301 except as noted herein.

D. Admixtures
1. Except as specified otherwise, water reducing and retarding admixtures may be used with prior approval of the Engineer.
2. The Contractor shall be responsible for compatibility of all admixtures.

3.02 PROPORTIONING

A. Accurately proportion concrete materials and mix to produce a homogeneous and workable mixture having the consistency and minimum compressive strength specified herein.

B. Proportion concrete materials by weight. Use equipment and methods that are acceptable to the Engineer when measuring ingredients.

C. Use the minimum amount of water and cement necessary to produce a concrete mixture of the required strength and consistency.
   1. Do not exceed the water-cement ratio specified herein.
   2. The cement content shall not be less than that specified herein.

D. Compressive strength may not necessarily be the most critical factor in proportioning concrete mixes.
   1. Other factors, such as durability and watertightness, may require lower water-cement ratios than are required to meet strength requirements.
   2. In such cases compressive strength will, of necessity, be in excess of that specified.

E. Use the minimum cement content and maximum water-cement ratios as shown below:

<table>
<thead>
<tr>
<th>Maximum Aggregate Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>Class of Concrete</td>
</tr>
<tr>
<td>Minimum Cement Factor, Sacks/cy</td>
</tr>
<tr>
<td>A</td>
</tr>
<tr>
<td>B</td>
</tr>
<tr>
<td>Maximum Water-to-Cement, Ratio, lb./lb.</td>
</tr>
<tr>
<td>A</td>
</tr>
<tr>
<td>B</td>
</tr>
<tr>
<td>Maximum Water-to-Cement Ratio, Gal./Sack</td>
</tr>
<tr>
<td>A</td>
</tr>
<tr>
<td>B</td>
</tr>
</tbody>
</table>

F. Base the water content of the mix on the total amount of water in the mixture,
   1. Include any free water in the aggregate or adhering to the surface of the aggregate.
2. Do not include water absorbed by the aggregate.

G. Determine the total volume of aggregate used in each cubic yard of concrete by recognized standards for designing concrete mixes. Use the actual screen analysis of the aggregates.

H. The proportion of fine and coarse aggregate shall be such that the ratio of the coarse to the fine based on weight shall not be less than 1.0 or more than 2.0.

3.03 MIXING CONCRETE

A. Use mixing equipment that is capable of combining the aggregates, cement, admixtures, and water within the time specified into a thoroughly mixed and uniform mass.

B. Mix concrete by one of the following methods:
   1. Operation of one or more batch-type mixing plants, each with a rated capacity of ½ cubic yard or more, installed at the site of work;
   2. Operation of a proportioning plant installed in the vicinity of the work and the use of transit mixers for mixing concrete and transporting it to the forms.
   3. Use of ready-mixed concrete from a central mixing and proportioning plant.
   4. Remote dry-mix batch plant may be used only with approval of the Engineer.

C. The mixing method selected by the Contractor shall be subject to the approval of the Engineer.

D. Provide mixing and proportioning plants with equipment and facilities to accurately measure and control the quantities of material and water used in the concrete. Include provisions to readily change the proportions to conform to the varying conditions and requirements of the work.

E. Stationary Mixed Concrete
   1. Use a batch mixer of an approved type which will ensure a uniform distribution of materials throughout the mass.
      a. Accurately proportion and control all materials entering the drum, including water.
      b. Proportion the cement and aggregate by weight. Volumetric batching will not be allowed.
      c. Equip the mixer with an automatic timing device to lock the discharge level before aggregate and cement enters the drum. Release such level only after the specified mixing time has elapsed.
      d. Comply with the “Concrete Mixer Standards” adopted by the Mixer Manufacturer’s of the Associated General Contractors of America. Provide a nameplate giving the manufacturer’s rated capacity of the mixer.
   2. Discharge the entire batch before recharging the mixer.
      a. Do not exceed the manufacturer’s rated capacity of the mixer.
      b. Mix each batch for the period indicated herein, during which time the drums shall rotate at a peripheral speed as recommended by the manufacturer.
3. Mixing time shall be as follows:

<table>
<thead>
<tr>
<th>Capacity of Mixer</th>
<th>Mixing Time in Seconds</th>
</tr>
</thead>
<tbody>
<tr>
<td>½ cubic yard</td>
<td>75</td>
</tr>
<tr>
<td>¾ to 1 ½ cubic yards</td>
<td>75</td>
</tr>
<tr>
<td>Larger than 1 ½ cubic yards</td>
<td>120</td>
</tr>
</tbody>
</table>

4. Measure mixing time from the time all cement and aggregates and most of the water are in the mixer.
   a. Excessive over-mixing, requiring additional water to preserve the required consistency will not be permitted.
   b. All of the mixing water shall be introduced before ¼ of the total mixing time has elapsed.

F. Transit Mixed Concrete
   1. Conform to the following:
      a. The current “Standards for Operation of Truck Mixers and Agitators of the National Ready-Mixed Concrete Association,”
      b. The “Truck Mixer and Agitator Standards of the Truck Mixer manufacturers Bureau,”
      c. ASTM C94.
   2. Transit Mixer
      a. Automatically record the number of revolutions of the drum during the mixing period.
      b. Attach a metal plate on each mixer and agitator in a prominent location. Plainly mark the following:
         (1) Capacity of the drum in terms of the volume of mixed concrete
         (2) The speed of rotation for the agitating and mixing speeds of the mixing drum or mixer blades.
      c. Paint an identification number on each mixer in a location that can be easily read from the batching platform.
      d. Do not exceed the manufacturer's guaranteed mixing capacity.
   3. Reduce the amount of materials charged into the mixer if the concrete does not meet the uniformity requirements of this specification.
   4. Completely empty the mixer drum of any previously mixed load.
      a. Place the proper proportions of aggregate, cement, and water for each load of concrete in the mixer.
      b. Mix the contents therein for not less than 70 or more than 100 revolutions of the drum or mixer blades. Use the speed designated by the equipment manufacturer as the mixing speed.
      c. For additional drum revolutions, use the speed designated by the equipment manufacturer as the agitating speed.
d. Immediately prior to discharging the concrete, revolve the drum at the mixing speed for a minimum of three minutes.

e. Revolution of the drum shall be continuous until the concrete is completely emptied from the drum.

5. Class A concrete: Empty all wash water from the mixer before any portion of the succeeding load is placed therein.

6. Class B concrete: Empty the mixer or carry no more than 10 gallons of water in the drum.

7. Add water at the point of discharge only with the prior approval and in the presence of the County’s representative and in the presence of the concrete testing representative.
   a. Mix water so added into the load for a minimum mixing time of three minutes.
   b. Do not add water to the load during transit.

8. Do not exceed 90 minutes between the time water is added to the cement and aggregate or cement is added to the water and aggregate and the time concrete is placed in the forms, except if retarding admixtures are utilized and approved by the Engineer.
   a. When allowed by the Engineer, use a water-reducing and retarding admixture whenever concrete cannot be delivered to the forms within the time period specified.
      (1) Use only to supplement (not to replace) other acceptable hot weather procedures.
      (2) The retarding admixture used shall not interfere with strength development and other properties of the concrete.
      (3) Retarding admixture use shall be carefully controlled by the concrete supplier.
      (4) Test with job site materials and demonstrate the admixture’s ability under these conditions to produce the desired properties before using.

9. Add water at the job site to offset evaporation of mixing water only with the Engineer’s approval and in the presence of a designated County representative.
   a. The addition of any water during transit to offset evaporation losses is not permitted.

10. Avoid prolonged mixing, even at agitating speed. Where feasible, stop the mixer and then agitate intermittently.

11. Provide the County’s representative with a legible, certified weighmaster’s certificate for each load of ready-mixed concrete.
   a. Provide at the time of delivery.
   b. Delivery ticket shall be identical to that submitted and approved with the concrete mix design.
   c. All information shall be entered on to the delivery ticket at the mixing plant except the following:
      (1) Blank space for initials of on site receiving party.
(2) Time of arrival of concrete truck on site.
(3) Amount of mix water added on-site.
(4) Time of concrete placement.

3.04 CONVEYING CONCRETE
A. Convey concrete from the mixer to the place of final deposit by methods that will prevent separation or loss of the materials.
B. If the concrete is to be transported more than fifty feet in carts or buggies, equip them with pneumatic tires.
   1. Deliver concrete to the carts, buggies or conveyors from spouts, troughs, or mixer trucks.
   2. Do not allow a free fall of more than three feet.
   3. Prevent the separation or loss of ingredients.
   4. Keep delivery carts, buggies, conveyor trucks or barrows on temporary runways built over the floor system. Do not allow runway support to bear upon reinforcing steel or fresh concrete.

3.05 CONCRETE PLACEMENT
A. General
   1. Ensure the following before placing concrete:
      a. All reinforcement is securely and properly fastened in position and protected against displacement
      b. All items to be embedded in the concrete are in place and securely anchored in position
      c. All forms have been thoroughly coated or wetted
      d. All form ties at construction joints have been retightened
      e. Concrete surfaces to be covered have had all free water, form coating, loose concrete, and debris removed,
      f. All conveyances, buggies, and barrows are clean and wetted.
   2. Notify County’s representative at least 24 hours prior to placing concrete.
      a. The County’s representative will inspect forms, reinforcing steel, screeds, construction joints, openings, anchors, pipe sleeves, conduit, and inserts.
      b. Do not pour concrete until the condition of the forms and place of pouring has been inspected and approved by the County’s representative.
      c. Wet down formwork and reinforcement before placing concrete to prevent the leaching of water from the concrete.
      d. Do not allow free standing water in the forms.
      e. Do not place concrete when the sun, wind, heat, or humidity prevents proper placement and consolidation.
      f. Do not add water or cement to the mix without the Engineer’s approval or in the absence of the County’s representative. Do not deposit partially hardened concrete.
B. Placing Concrete

1. Unless otherwise specified, place all concrete upon clean, damp surfaces, free from water.
   a. Do not place concrete upon soft mud, dry absorbent earth or rock.
   b. Do not place concrete upon dills that have not been tamped to provide ultimate settlement.

2. Maintain groundwater below subgrade until the concrete has set. When subgrade is dry earth, thoroughly dampen soil with water to ensure that no moisture is absorbed from the fresh concrete.

3. Where shown on the Drawings, directed by the Engineer or where concrete is placed against gravel or crushed rock with less than 25% of the material passing a No. 4 sieve; cover the surfaces against which concrete is cast with polyethylene film to protect the concrete from loss of water.
   a. Lap joints in the film at least 12 inches and tape.
   b. Protect the polyethylene film against puncture from the underlying crushed rock.
      (1) Use a cushion of natural or imported sand complying with ASTM D1073
      (2) Place the sand on top of the crushed rock.
      (3) Where concrete is placed against rock, remove all loose pieces of rock and clean the exposed surface with a high-pressure hose.

4. Place concrete within 90 minutes after adding cement, aggregates, water and admixtures.

5. Dispose of concrete which has not been placed within these time limits off site.


7. Comply with ACI 301 when bonding new concrete to existing concrete.
   a. Apply approved bonding compound.
   b. Allow bonding compound to cure in accordance with the manufacturer’s recommendations or as directed by the County’s representative.

8. Place a vapor barrier under all slabs poured on earth.
   a. Extend the barrier the full area of the slab.
   b. Turn barrier up or down footings as indicated.
   c. Lap all seams at least 12 inches and seal per manufacturer’s instruction.
   d. Install reinforcement with care so as not to puncture vapor barrier.
   e. Tape all cuts, tears, punctures, and pipe penetrations before pouring concrete.

9. Deposit concrete in batches in its final position to prevent segregation of the mix.
   a. The limits of each concrete pour shall be predetermined by the Contractor and approved by the Engineer. Place all concrete within such limits in one continuous operation.
b. Do not move concrete laterally in the forms more than 5 feet.
c. Use a crane and a bottom dump concrete bucket wherever possible.
d. Unless authorized by the Engineer, do not drop concrete freely into place from a height of greater than 5 feet.

1. Deposit concrete in walls by means of prefabricated, rectangular tremies, constructed in short sections and spaced laterally not over 5 feet apart.

2. Take special care to avoid slopping concrete over forms when placing.

10. After the concrete has been deposited, distribute it over the entire area within the forms in approximately horizontal layers of not more than 18-in. deep.

a. Bring up the layers evenly in all parts of the form.
b. Ensure each concrete layer is still plastic when covered with the succeeding layers.
c. Fill the forms at a rate of vertical rise of not less than 2-ft per hour or more than 6-ft per hour.
d. Stop concrete placement if a layer of concrete reaches its initial set before the next lift is placed, or if more than 60 minutes elapses between the placing of successive concrete lifts.
e. Prepare the surface of the previous lift in accordance with the procedures specified under Construction Joints in this Section.

11. Do not allow workmen to walk on concrete during placing or finishing with any earth or foreign matter on footgear.

a. Use forks and shovels for hand spreading
b. Do not use rakes.

12. Place and compact concrete in wall or column forms before any reinforcing steel is placed in the structural system to be supported by such walls or columns.

a. Do not exceed 6 feet of vertical height for any portion of a wall or column placed monolithically with a floor or roof slab.
b. Allow concrete in walls or columns to set at least two hours before concrete is placed in the structural systems to be supported by such walls or columns.
c. Pour brackets, haunches and fillets monolithically with the floor or roof slab system.

C. Consolidation

1. Thoroughly consolidate concrete during and immediately after placement.

a. Work concrete into all corners and angles and around reinforcement and embedded fixtures in a manner to fill all voids, prevent honeycombing against the forms and avoid segregation of coarse aggregate.
b. Use spades, forks and internal vibrators to perform this operation.

2. Transmit vibration directly to the concrete. Do not transmit it through the forms.

a. Use a vibrator with a driving mechanism that revolves at not less than 7,000 rpm.
b. Vibrate with sufficient intensity to cause the concrete to flow and settle readily into place and to visibly affect the concrete over a radius of at least 18 inches.

c. Supplement vibration with manual forking or spading adjacent to the forms on exposed faces in order to secure smooth, dense surfaces.

d. Take special care to consolidate around reinforcement, pipes and other shapes built into the work.

e. Do not use vibrators to transport concrete within the forms.

f. Keep vibrators in motion at all times to prevent excessive vibration in one spot. The operation shall be continuous and all concrete shall be in final position before initial set has started.

3. Maintain at least one operable vibrator on site as a spare in case of equipment failure. Do not place any concrete until all vibrating equipment, including spares, are at the placement site.

4. Thoroughly consolidate concrete prior to top finishing.

a. Remove all laitance, debris, and surplus water from concrete surfaces at tops of forms by screeding, scraping, or other effective means.

b. Wherever the top of a wall will be exposed to weathering, overfill forms; and after the concrete has been compacted, screed off excess.

D. Placement Sequence

1. Unless otherwise indicated on the Drawings or directed by the Engineer, follow the placement sequence identified below to reduce shrinkage cracking:

a. Bottom Slab
   (1) Place a center section first.
   (2) Not less than 72 hours after the center section has been placed, place an adjoining section.
   (3) Place the remaining sections alternately, first on one side and then on the other side of previously placed sections.
   (4) Schedule pours so that two adjacent sides of each section are free, except at closures.

b. Walls
   (1) Divide walls into sections by the construction joints shown on the Drawings or as submitted by Contractor.
   (2) Place a section near the center of each wall first.
   (3) Place the remaining sections alternately, first on one side and then on the other side of the previously placed section.
   (4) Schedule pours so that one end of each section is free, except at corner closures.

c. Footings
   (1) Pour all footings except wall footings in one operation with no joints unless noted otherwise on the contract drawings.
E. Special Requirements Due to Adverse Weather Conditions

1. Rain
   a. Do not place concrete during rain.
   b. Do not place concrete if rain is forecast unless there is sufficient time to complete the placement and finishing.
   c. Protect all concrete placed prior to rain by whatever means necessary to prevent damage to finish or water entering the mix.
      (1) Maintain protection equipment and materials on hand prior to beginning placement operations.
      (2) Protect freshly placed concrete from scour by flowing water and from mud deposits or other injurious conditions.

2. Cold weather concrete placement
   a. Comply with ACI 306, except as modified herein
   b. Ensure the concrete temperature at the time of placing is not less than that shown in the following table for the corresponding ambient outdoor air temperature (in shade) existing at the time of placement:

<table>
<thead>
<tr>
<th>Ambient Outdoor Air Temperature</th>
<th>Minimum Concrete Temperature</th>
</tr>
</thead>
<tbody>
<tr>
<td>Below 35° F</td>
<td>70° F</td>
</tr>
<tr>
<td>Between 35° F and 45° F</td>
<td>60° F</td>
</tr>
<tr>
<td>Above 45° F</td>
<td>45° F</td>
</tr>
</tbody>
</table>

   c. Do not place concrete when the ambient air temperature at the time of placement is 45° F or less unless specifically authorized by the Engineer.
      (1) Heat the concrete in a manner acceptable to the Engineer.
      (2) If the use of heated concrete is authorized, temperature of the concrete at time of placement shall not exceed 80° F.
      (3) Avoid rapid dry-out due to overheating.
      (4) Avoid thermal shock due to sudden cooling or heating.
   d. Maintain the air temperature surrounding the concrete at 70° F for three days, or 50° F for five days, or for as long as is necessary to ensure proper curing of the concrete.
      (1) Prevent rapid cooling of the concrete.
      (2) Leave housing, covering, or other protection used in connection with heating in place and intact at least 24 hours.
      (3) Chemicals to prevent freezing shall not be permitted.
   e. Do not place concrete on frozen subgrade or subgrade containing frozen materials. Ensure forms, reinforcing steel, and adjacent concrete surfaces are completely free of frost, snow and ice before placing concrete.

3. Hot weather concrete placement
   a. Comply with ACI 305 except as modified herein.
b. Follow hot weather precautions whenever the maximum ambient outdoor air temperature (in shade) during the day exceeds 85°F.
   (1) Cover reinforcing steel with water soaked burlap so the steel temperature does not exceed the ambient air temperature immediately before embedment in concrete.
   (2) Do not place concrete when hot weather conditions may result in loss of slump, flash set or cold joints.

c. If rapid mixing water evaporation in transit causes the concrete to be delivered in an unworkable condition, initial correction may be made at the job site.
   (1) Add water in the form of a cement paste having the same water to cement ratio as the batch in the truck.
   (2) Operate the drum or mixer blades at mixing speed for at least 70 revolutions after the paste addition.
   (3) Once need for water has been observed, subsequent additions shall be at the batching plant until the need has passed.
      (A) Provide a simultaneous and proportionate increase of water and cement, up to 10% of the stated quantity of each material in the batch.
      (B) Such increases in cement shall not constitute grounds for an increase in the contract price.

d. Do not exceed a concrete temperature of 85°F at the time of placement.

e. Take extra caution to prevent rapid evaporation of water.
   (1) Cool forms by frequent wettings.
   (2) Protect flat work from drying winds, direct sun, and high temperatures whenever conditions of temperature and humidity are such as to cause plastic shrinkage cracking.
   (3) Do not use set control admixtures in mix designs unless approved by the Engineer in advance.

f. In order to prevent plastic shrinkage cracking due to rapid evaporation of moisture, do not place concrete when the rate of evaporation, determined by using Figure 2.1.4 in ACI 305, latest edition, equals or exceeds 0.2 pound per square foot per hour.

3.06 FINISHES

A. Finish concrete surfaces as set forth in these Contract Documents and as specified in ACI 301.

B. Formed surfaces
   1. Begin finishing immediately after form removal. Complete concrete finishing in that area before any other work begins.
   2. Provide a smooth-rubbed finish in accordance with ACI-301 for all permanently exposed surfaces and two (2) feet below high water elevation.
      a. Clean all holes, pits or imperfections in the concrete surface with a wire brush.
b. Thoroughly wet the concrete and completely fill imperfections with damp cement mortar composed of 1 part portland cement to 2 parts fine aggregate.

c. Make the entire surface smooth with all lines or markings smoothed over to obtain uniform appearance.

d. Prior to the commencement of concrete work the contractor shall provide a 5' x 5' concrete sample panel displayed vertically with a smooth-rubbed finish for approval by the County's representative. Once the smooth-rubbed finish of the sample panel has been approved all applicable concrete finishes shall meet the quality of the sample panel. If, in the opinion of the County's representative, the concrete surface is unsatisfactory, repair it as follows:

   (1) Thoroughly and continuously wet the entire surface.

   (2) Rub the surface with a No. 0 carborundum stone until all lines, markings and surplus materials have been removed from the surface. When complete, wash the surface clean with water.

   (3) Rubbing may be done either by hand or with power tools.

C. Unformed surfaces

1. Buried or permanently submerged concrete not forming an integral part of a structure does not need surface treatment except as that required to remove laitance.

2. Screed the unformed surfaces of all other concrete and give it the following treatment:

   a. An initial float finish.

   b. Additional floating followed by troweling where required.

   c. Take care that no excess water is present when the finish is made.

   d. Do not use a special concrete or cement mortar topping course unless shown on the Drawings.

3. Screeding

   a. Use a straight edge and accurately and securely set screeding strips to produce an even surface.

   b. Arrange screeds so as not to interfere with the top bar reinforcement.

   c. Provide a concrete surface conforming to the proper elevation and contour with all aggregates completely embedded in mortar. Ensure surfaces are free of surface irregularities with a height or depth in excess of ¼-inch as measured from a 10-foot straight edge.

4. Floating

   a. Give screeded surfaces an initial float finish as soon as the concrete has stiffened sufficiently for proper working.

      (1) Remove any coarse aggregate which is disturbed by the float or which causes a surface irregularity. Replace it with mortar.

      (2) Produce a surface of uniform texture and appearance with no unnecessary working of the surface.

   b. Follow initial floating with a second floating at the time of initial set.
(1) Produce a finish of uniform texture and color.
(2) This is the completed finish for unformed surfaces unless additional finishing is specifically required.

c. Use hand floats or suitable mechanical compactor floats.

5. Brooming
a. Provide a non-slip surface.
b. Perform after the second floating.
c. For traffic areas, perform at right angles to the normal traffic direction.

6. Troweling
a. Provide a steel trowel finish for surfaces to be covered with resilient floor coverings and other surfaces designated on the Drawings.
b. Trowel finishing will not be required for floors, which are normally submerged.
c. Perform troweling after the second floating when the surface has hardened sufficiently to prevent an excess of fines being drawn to the surface.
d. Produce a dense, smooth, uniform surface free from blemishes and trowel marks.

7. Edging
a. Chamfer all permanently exposed edges of unformed surfaces.
b. Use a ¾-in approved edging tool unless other edge treatment is indicated on the Drawings.

D. Unless otherwise specified or required, provide the following finishes:
1. Curbs and equipment bases: broom finish
2. Exterior slabs: broom finish, Class B tolerance.
3. Interior slabs: troweled finish, Class A tolerance.
4. Other concrete not exposed to view: rough form finish.

E. Other concrete exposed to view: Smooth form finish with voids filled and rubbed smooth.

3.07 CURING, PROTECTION
A. Cure and protect concrete as specified in ACI 301 and as set forth in these Contract Documents.

B. Protect from loss of moisture by curing for at least 14 days following placement.
1. Begin immediately after concrete finishing is complete or forms are removed.
2. Breaking of form ties or otherwise breaking the seal between the concrete surface and the form shall be considered form removal.

C. Use water curing, membrane curing, film curing, or any other curing method acceptable to the Engineer which does not injure or discolor exposed surfaces nor destroy the bond on surfaces to receive subsequent concrete pours or protective coatings.

D. Water Curing
1. Keep concrete surfaces being water-cured constantly and visibly wet for a period of not less than 14 days.
a. Saturate concrete surfaces as quickly as possible after the initial set of the concrete.

b. Regulate the rate of water application to provide complete surface saturation with a minimum of runoff.

2. Slabs poured on grade and decks may be water-cured by the following methods:
   a. Ponding. Standard canvas seep hose placed in parallel runs on 8-foot centers is recommended for ponding.
   b. Covering with wet burlap sacks, sand, or sawdust and keeping this covering continually and visibly wet during this period.

3. Walls may be cured by leaving the forms tied in place and keeping the forms and all exposed surfaces of the concrete continually and visibly wet for the duration of the curing period.

E. Membrane Curing

1. Use for all interior slabs to be covered with resilient tile, carpet or left exposed and all exterior slabs, sidewalks, curbs, etc. Apply in strict accordance with the manufacturer’s recommendations.

2. Apply the curing and sealing compound by power spray, roller, or squeegee.
   a. Use a coverage rate not to exceed 400 sq. ft. per gallon for troweled surfaces.
   b. Use a coverage rate not to exceed 300 sq. ft. for floated or broomed finishes.

3. Apply the curing and sealing compound immediately after final finishing (within 30 minutes).
   a. If forms are removed before the end of the specified curing period, the curing and sealing compound or other moisture retaining method must be applied to the formed surfaces before they dry out.
   b. The County’s representative shall determine which method shall be used.

4. Protect the curing compound against abrasion during the curing period. If the compound will be subjected to damage from traffic or other cause, protect it with Sisalcraft paper or other means acceptable to the County’s representative.

5. Reapply improperly applied Compound or compound applied without sufficient dye to produce a distinguishing color to the satisfaction of the County’s representative.

F. Film Curing

1. Film curing with polyethylene sheeting may be used in lieu of water curing on concrete that will be covered later with mortar or additional concrete or will otherwise be covered or hidden from view.

2. Begin film curing as quickly as possible after initial set of the concrete.
   a. Completely cover the surfaces with polyethylene sheeting.
   b. Overlap the sheeting edges sufficiently to obtain proper sealing and anchorage.
      (1) Overlap joints between sheets at least 12 inches and seal.
      (2) Promptly repair all tears, holes, and other damage.
3.08 CONSTRUCTION JOINTS

A. Use construction joints only at locations indicated on the Drawings or specified herein.
   1. Do not use at other locations without concurrence of the Engineer.
   2. Do not use vertical construction joints in walls unless specifically approved by the Engineer.
   3. Lay out and conduct the work to minimize the number of construction joints.

B. Use only keyed construction joints.
   1. Make keys continuous.
   2. Make the key width equal to 1/3 of the thickness of the wall and the key depth equal to 1/6 of the thickness of the wall.
   3. Do not use keys smaller than 3-in wide and 1½-in deep unless indicated otherwise on the Drawings.

C. Provide waterstops of the type specified where indicated on the Drawings and in all construction joints in concrete walls and slabs having one face exposed in a dry pit or room and having the other face in contact with backfill, subgrade, groundwater, or other liquid.

D. Thoroughly clean the horizontal surface immediately before placing the next lift using water or air as required.
   1. Cover the concrete surface with a uniform, evenly distributed layer of cement-sand mortar to a thickness of 1-in.
   2. Make the cement-sand mortar using a mixture of 1.3 parts by volume Portland Cement and 1 part by volume fine aggregate. Use a water-to-cement ratio equal to that of the concrete to follow.

3.09 EXPANSION AND CONTRACTION JOINTS

A. Provide expansion joints as shown on the Drawings. If not shown use full-depth, pre-formed, ½-in asphalt plank material conforming to ASTM D994.

B. PVC, Hydrophilic Rubber, Mastic and compression seal waterstop joints
   1. Install in strict accordance with the manufacturer’s recommendation and these specifications.
   2. In case of conflict, use the most stringent requirement as determined by the Engineer.

C. Hydrophilic Rubber:
   1. Cut coil ends square (or at proper angle for mitered corners) with shears or sharp blade to fit splices together without overlaps.
   2. Seal splices using cyanacrylate adhesive
   3. Seal any exposed cells of Hydrophilic Rubber using LEAKMASTER by Greenstreak or approved equal. Make watertight.

D. Compression Seal:
   1. Seal field butt splices shall be using Greenstreak “G-SEAL” adhesive or approved equal.
2. Attach compression Seal to expansion board using staples or nails driven through bottom flange area of the Compression Seal.

3. Attach Compression Seal prior to concrete placement.

E. Mastic:
1. Inspect waterstop for discontinuity and debris contamination prior to concrete pour. Replace unacceptable waterstop.
2. Adhere waterstop to concrete utilizing primer adhesive.
3. Allow primer adhesive to dry for two (2) hours prior to application of waterstop.
4. Keep waterstop free from moisture, dirt, oil, and sunlight during the progress of the work.
5. Splice waterstop by overlapping ends and pressing ends together in a molding action ensuring no separation or air pockets.
6. Remove the separation paper from the waterstop just prior to second pour of concrete.

3.10 BONDING NEW CONCRETE TO EXISTING CONCRETE

A. Where new concrete is to be cast against and permanently bonded to an existing concrete surface, chip or cut the existing concrete back at least 1½-in or as necessary to expose sound concrete.

1. Remove loose or weathered concrete and provide a roughened surface for bonding to the new concrete.
2. Cut edges square. Feathered edges will not be permitted.
3. Remove all loose material remaining after chipping or cutting operations by sandblasting and/or stiff wire brushing.

B. Where chipping back of existing concrete is not possible and where approved by the Engineer, the surface of existing concrete may be prepared by sandblasting or acid etching.

1. Ensure the surface of the existing concrete is bare, clean, dry, and structurally sound.
2. Remove all grease, oil, wax, or other residue by scraping followed by washing with a nonionic detergent or a suitable solvent compatible with the epoxy-bonding agent to be used.
3. Remove animal fats by scrubbing with a 10% solution of caustic soda to saponify them.

C. After all loose material, grease, etc., has been removed, etch the surface of the existing concrete by either sandblasting or scrubbing with a 10%-20% solution of hydrochloric acid in water.

1. Apply etching solution at a rate of 1-quart per square yard followed by a thorough rinsing with clean water.
2. Allow the surface to completely dry before applying the epoxy-bonding agent.
3. Wear goggles, rubber boots, and rubber gloves when applying caustic soda or acids.

D. When the surface is dry and just before placing the new concrete, apply an epoxy bonding agent to the surface of existing concrete with a whitewash brush or stiff broom.
1. Spread the epoxy bonding agent evenly over the surface to be bonded, avoiding skips and holidays, to a wet film thickness of 40 to 60 mils.

2. Place the new concrete as soon as the epoxy-bonding agent becomes tacky.

3. If the epoxy-bonding agent is allowed to dry before placement of new concrete, recoat the surface with epoxy.

E. The epoxy-bonding agent shall comply with the material requirements of this specification
   1. Apply the material in strict conformance to the manufacturer’s recommendations.
   2. Take appropriate safety precautions during the handling and use of the epoxy-bonding agent.

3.11 EMBEDDED ITEMS

A. Wherever steel, wrought or cast iron piping, fittings, valves, collars, sleeves, structural steel, electrical conduits, appurtenances and fixtures, equipment anchorages or castings are shown for embedment in the concrete, such items must be on hand before concrete is poured.
   1. Accurately set embedded items in place.
   2. Firmly brace items before concrete is poured around them.
   3. Do not use cutouts for future installation of these items.

B. Thoroughly clean embedded items and ensure they are free from any coating, rust, scale, oil or other foreign matter.
   1. Avoid embedding wood in concrete whenever possible.
   2. If wood must be embedded, thoroughly wet it before the concrete is placed.
   3. After placement, clean surfaces not in contact with concrete of concrete spatter and other foreign substances.

C. Install conduit between reinforcing steel in walls or slabs that have reinforcement in both faces. In slabs with only a single layer of reinforcing steel, place conduit under the reinforcement.

D. Unless installed in pipe sleeves, embed anchor bolts with sufficient threads to permit a nut and washer to be installed on the concrete side of the form or template.
   1. Provide a second nut and washer on the other side of the form or template.
   2. Adjust the two nuts so that the bolt will be held rigidly in the proper position.

E. Coordinate the work and ensure that all embedded items or openings are placed in the forms before concrete is placed. Also confer with subcontractors and suppliers regarding their embedment and opening requirements.
F. Set forms, sleeves, and inserts, and cast concrete to the lines and grades indicated on the Drawings and as detailed in these Contract Documents.

1. Do not exceed the maximum deviation from true line and grade shown below. Deviation in alignment of slabs or walls shall not exceed a rate of 1/8-inch in 10 feet within the tolerances specified.

<table>
<thead>
<tr>
<th>Item</th>
<th>Maximum Tolerance (in.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sleeves and inserts</td>
<td>+ 1/8</td>
</tr>
<tr>
<td></td>
<td>- 1/8</td>
</tr>
<tr>
<td>Projected ends of anchor bolts</td>
<td>+ 1/4</td>
</tr>
<tr>
<td></td>
<td>- 0.0</td>
</tr>
<tr>
<td>Anchor bolt setting</td>
<td>+ 1/16</td>
</tr>
<tr>
<td></td>
<td>-1/16</td>
</tr>
<tr>
<td>Concrete forms</td>
<td>+ 1/8</td>
</tr>
<tr>
<td></td>
<td>-1/8</td>
</tr>
</tbody>
</table>

*Or as outlined in ACI 117 and approved by the Engineer

G. Carefully finish all slabs true to grade such that the surface is free draining and contains no depressions that can hold or collect water.

H. Regardless of the tolerances listed herein, limit deviations in line and grade to tolerances that will permit proper installation and operation of mechanical equipment and piping.

3.12 CONCRETE EMBEDMENT AND PIPE ENCASEMENT

A. Install concrete for embedment and encasement where shown on the Drawings and at such other locations where deemed necessary to protect existing or proposed piping as determined by the County’s representative.

B. Embedment and encasement of pipe shall include the following steps:

1. Remove all loose material from the trench before placing concrete. Ensure concrete will be in continuous contact with undisturbed soil on sides and bottom of trench.

2. Accurately screed a base course of concrete to such grade and elevation that the pipe will be at specified grade when pipe bells are supported on, and in contact with, the top surface of such base course.

3. Rigidly hold each length of pipe in alignment and anchor it to prevent flotation in a manner acceptable to the County’s representative.

3.13 ACCEPTANCE OF STRUCTURE

A. For environmental engineering structures as defined by ACI 350, concrete strength will be acceptable if it meets the acceptance criteria of ACI 301 and ACI 350, whichever is the more stringent. The Engineer may, however, reject the concrete, if cores fail to meet the specified 28 day strength.

B. For structures other than environmental engineering structures, the concrete strength will be acceptable if it meets the acceptance criteria of ACI 301.

C. The Engineer shall be the sole judge of concrete strength acceptability. Concrete not meeting the above requirements shall be removed from the project site, disposed of properly, and replaced with concrete meeting the specified requirements.

D. All structures which contain water shall be subject to a hydrostatic leakage test using the procedures that follow:

1. Do not begin cleaning and testing for at least 14 days after the concrete has been poured and the joints sealed.

2. Clean exposed surfaces prior to testing.
a. Thoroughly hose all surfaces to remove surface laitance and loose matter.

b. Remove wash water and debris from structures. Do not use plant piping for removal.

3. Test structures before backfill is placed against the walls. Ensure that all concrete has attained its specified compressive strength prior to testing.

4. Provide all required piping, valves, meters, and related equipment necessary to test the structures. Coordinate with the County's representative.

5. Fill structures to be tested with potable water to the normal operating liquid level indicated on the contract drawings or otherwise provided by the Engineer.
   a. Do not exceed a filling rate of 4 feet of water depth per 1-hour period.
   b. Fill at a uniform rate with continuous monitoring.
   c. For structures with adjacent bays, fill all bays simultaneously.
   d. Empty adjacent bays alternately.
   e. Repair all running leaks that appear during filling prior to continuing.

6. Add water as necessary to keep the structure at its normal operating level indicated on the contract drawings or otherwise provided by the Engineer for 72-hours.
   a. At the end of 72-hours, it will be assumed that moisture absorption by the concrete is complete.
   b. Close all valves and gates to and from the structure
   c. Measure the change in water surface each day for a 5-day period. If the water level drops more than 1/100 of 1% of the normal liquid volume in a 24 hour period excluding evaporation, the leakage loss shall be considered excessive.
   d. Examine exposed portions of the structure and mark all visible leaks and damp spots.
      (1) Damp spots shall be defined as areas where moisture can be felt on a dry hand.
      (2) Repair visible leaks and damp spots after the structure is dewatered.
   e. Determine surface moisture evaporation using a 24-inch deep, white colored, watertight container of not less than 10 square foot surface area exposure.
      (1) Position the container to experience environmental conditions similar to the structure being tested.
      (2) Fill the container with a known volume of water.
      (3) Measure the water loss due to evaporation each day and determine the loss in gallons per square foot of surface area.
      (4) Use the evaporation rate determined above to calculate the quantity of water lost from the test structure due to evaporation.
      (5) Subtract the water loss due to evaporation from the measured water loss in the structure being tested to determine the water loss due to leakage.
f. If leakage is excessive, drain the structure.
   (1) Repair the leaks and damp spots.
   (2) Refill the structure using the procedures outlined above and re-
   test.
   (3) Continue the process until the results meet these specifications.

7. Seed the floor slab of each water containing structure with one bag of cement per
   250 square feet of surface area.
   a. Seed the structure after the test filling has reached 18-inches in depth.
   b. Detect leaks in construction and expansion joints with the aid of a diver.
   c. Stir cementitious deposits on the floor and observe the deposits flowing
      toward leaks.
   d. Repair all defects.

E. All repairs, additional fillings, and testing shall be performed by the Contractor at no
   additional cost to the Owner.
   1. Repair leaking concrete cracks as approved by Engineer.

F. The Engineer may reject any fluid retaining structure that does not meet the acceptance
   criteria of ACI 301.1 for designation HST-VIO and the requirements of this specification
   for water tightness.
   1. All cost for repairs required to meet the above criteria and provide an acceptable
      water tight structure shall be borne by the Contractor.

3.14 DEFECTIVE WORK AND METHODS OF REPAIR

A. Remove and replace or repair all defective or damaged work as directed by the Engineer.
   1. Any work which is not constructed in accordance with these Contract Documents
      is defective.
   2. Do not patch, repair or cover defective or damaged work without prior inspection
      and approval of the County’s representative.

B. Repair defects in formed concrete surfaces to the satisfaction of the Engineer within 24-
   hours of placement.
   1. Replace defective concrete within 48-hours after adjacent forms have been
      removed.
   2. Cut out and remove honeycombed or otherwise defective concrete to sound
      concrete. Square cut the edges to avoid feathering.

C. Conform to Chapter 9 of ACI 301, except as modified herein.
   1. Do not interfere with the thorough curing of surrounding concrete.
   2. Adequately cure all repair work.

D. Where authorized by the County’s representative, patching conducted as specified herein
   may be used.
   1. Permission to patch shall not waive the Engineer’s right to have the defective
      work completely removed if the patch or repairs do not, in the Engineer’s opinion
      satisfactorily restore the quality and appearance of the work.
2. Patching shall be conducted as follows:
   a. Chip away defective areas at least 1-½” deep perpendicular to the surface
   b. Wet the area and 6” around it to prevent absorption of water from patching mortar.
   c. Brush a sand-cement grout consisting of one part fine aggregate to one part portland cement into the surface, following with patching mortar.

3. Patching mortar
   a. Use no more than one part portland cement to three parts fine aggregate.
   b. Use white portland cement to replace a portion of the gray cement as determined by a trial patch.
   c. Use only the minimum mixing water required for placing.
   d. Re-temper the mortar if necessary without the addition of water by allowing it to stand for one hour. Mixed with a trowel during that time to prevent setting.

4. Compact the Mortar into place and screed to leave the patch higher than the surrounding surface.
   a. Leave undisturbed for one to two hours to permit initial shrinkage.
   b. Finish to match the adjoining surface.
   c. Cure patch in accordance with this specification section.

3.15 LOADS APPLIED TO NEW CONCRETE
   A. Do not impose loads upon new concrete until it has reached its specified 28-day strength.
      1. Loads include, but are not limited to, earth loads, loads exerted from bracing or shoring, wind loads, hydrostatic or hydraulic loads, equipment or vehicle loads, or loads exerted by stacked materials.
   B. Repair or replace concrete which has cracked or is otherwise damaged due to overloading or loading before required strength has developed, as determined by the Engineer.

END OF SECTION
PART 1 GENERAL

1.01 DESCRIPTION

A. This work specified in this section includes:

1. New fully-adhered roofing assembly, with accessories, to create a complete, weather tight and warranted system; including but not limited to:
   a. Vapor retarder
   b. Flat and tapered rigid board insulation
   c. Roof cover board
   d. Thermoplastic polyolefin (TPO) roof membrane
   e. Roof-edge and curb blocking, and other blocking as needed
   f. Fasteners
   g. Flashing
   h. Walk Pads
   i. Fascia system and extension
   j. Replacement roof drains

2. Full system warranty with a term of 20 years covering wind speed conditions of up to 100 mph.

1.02 PERFORMANCE REQUIREMENTS

A. Roof system shall withstand uplift forces as required by the 2006 International Building Code as referenced by the Maryland building performance standards.

B. System components shall have been tested to demonstrate capability to meet FM 1-90 standard.

1.03 SUBMITTALS

A. Submit in conformance with article SP-09 of the Special Provisions.

B. Submit product literature for components listed below, showing material properties, conformance of materials with requirements stated in these specifications, and clearly indicating proposed selections for options such as base material, material thickness, finish type, color and dimensions.

1. Vapor retarder
2. Insulation
3. Roof cover board
4. Roofing membrane
5. Preservative treatment system for wood blocking
6. All types of fasteners proposed for used in the roofing system
7. Flashing materials
8. Walkway protection
9. Fascia system
10. Replacement roof drains

C. Shop Drawings
1. Roof plan drawn to scale and showing all roof penetrations and layout of tapered insulation, including cants and crickets as needed to attain free movement of storm water to drains.
2. Fascia extension and cleat profiles

D. Letter from roof membrane manufacturer that:
1. Indicates project name and location
2. Describes the roof system assembly
3. States the duration and wind speed of the specified warranty
4. States the roof membrane manufacturer’s intent to provide the specified warranty after inspection of the installed roof

PART 2 PRODUCTS

2.01 MANUFACTURERS
A. Tiempo by Dow Roofing systems (formerly Stevens EP-XL)
B. Or equal

2.02 ROOF MEMBRANE
A. Thermoplastic polyolefin (tpo) reinforced
   1. 80 mil overall thickness
   2. 0.034-inch thickness over scrim
   3. No less than 390 lbf breaking strength per ASTM D-751
   4. No less than 104 lbf tear strength per ASTM D-751
   5. Passes ASTM D-1149 ozone resistance test with 70 hours at 100°F
   6. Passes ASTM D-2137 brittleness test at -49°F
   7. Initial solar reflectance greater than 70 percent per ASTM E-903
   8. Top face color: white

2.03 VAPOR RETARDER
A. Self-adhesive composite of rubberized asphalt laminated to a polyester fabric or polyethylene film.
   1. Overall thickness no less than 40 mils
   2. Elongation of rubberized asphalt layer of no less than 200 percent per ASTM D412.
   3. Tensile strength no less than 200 psi per ASTM D412.
   4. Water vapor transmission no greater than 0.05 perms per ASTM E96.
   5. Accepted by roof membrane manufacturer as a component in the warranted assembly.
2.04 INSULATION
A. Rigid polyisocyanurate board with fiber-reinforced nonasphaltic facers. Flat and tapered as required to attain specified minimum thickness and slope to drains.
   1. Minimum aged R-value of 6 per inch
   2. Minimum thickness of 2.5 inches
   3. Minimum compression resistance with 10 percent consolidation of 25 pounds per square inch (psi) per ASTM D1621.
   4. Compliant with ASTM C1289, Type II, Class 1, Grade 3.
   5. Water absorption of no more than 1.5 percent per ASTM D2842.
   6. Dimensional stability of less than 2 percent per ASTM D2126.
   7. Accepted by roof membrane manufacturer as a component in the warranted assembly.

2.05 ADHESIVE
A. Two-part urethane low-rise foam or other adhesive system approved by roof membrane manufacturer to meet wind uplift and other requirements to attain the specified warranty.

2.06 ROOF COVER BOARD
A. 0.5 inch densdeck prime as manufactured by Georgia-Pacific, or equal accepted by roof membrane manufacturer as a component in the warranted assembly.

2.07 PRE-FINISHED ALUMINUM FASCIA
A. Continuous cleat and fascia cover system as accepted by roof membrane manufacturer as a component in the warranted assembly.
   1. Fascia cover height of approximately 8-inches.
   2. Aluminum fascia cover with two-coat 70 percent PVDF finish in color selected by Engineer from manufacturer’s extended range of colors.
   3. Provide aluminum fascia extension and trim as shown by drawings, in finish to match fascia cover.
   4. All fasteners shall be 300 series stainless steel.

2.08 LUMBER AND BLOCKING
A. Preservative treated Southern Pine No.2 by SPIB rules; minimum Fb for single use up to 12-inch wide; 875 psi; minimum E; 1,400,000; 19 percent maximum moisture content.
B. Preservative treatment to be Wolman E by Arch Wood protection; ACQ by chemical specialties, inc; or Micropro by Osmose, inc.
C. Product shall not contain arsenic or chromium
D. Retention shall be per AWPA standard U1 use category system for CBA or ACQ products, or meeting ESP-1980 retention standards for MCQ formulations.
E. Lumber shall be kiln-dried after preservative treatment.
F. All lumber in contact with earth or concrete shall be pressure treated with preservative.
G. All fasteners in contact with lumber shall be stainless steel.
H. Roof membrane, self-adhesive flashing, or vapor retarder material shall separate aluminum, galvanized steel or plain carbon steel from preservative treated lumber.
2.09 ACCESSORIES AND FLASHING MATERIALS
   A. All components used in roofing assembly, including flashings and accessories, shall be as approved by the membrane manufacturer for use in the warranted system.

PART 3 EXECUTION
3.01 INSTALLATION
   A. All installation work shall be conducted as recommended or required by roof membrane manufacturer to attain the specified warranty.
   B. Verify that new hatch openings and supports are in place and ready to receive the new roof system.
   C. Notify Engineer of any deficiencies that may have to be corrected before processing with blocking installation.
   D. Secure roof edge and curb blocking to concrete with appropriate stainless steel fasteners.
   E. Verify that mechanical equipment curbs, roof scuttles and equipment access hatches are properly installed. Notify Engineer of any deficiencies that may have to be corrected before proceeding with priming and vapor retarder installation.
   F. Prime roof slab to receive vapor retarder
   G. Install vapor retarder over full extent of roof slab and up vertical faces of blocking equal to height of top surface of insulation
   H. Install flat and tapered insulation board with adhesives as required by membrane manufacturer to attain specified warranty. Layout subsequent layers of insulation such that joints between insulation boards do not align between layers. Form crickets and cants as required to facilitate drainage around curbs and other interruptions in the roof surface.
   I. Apply roof cover board with adhesives as required by membrane manufacturer to attain specified warranty.
   J. Install roof membrane and flashings as directed by membrane manufacturer to attain specified warranty.
   K. Install roof edge material and accessories to provide complete and warranted installation.

3.02 FIELD QUALITY CONTROL AND TESTING
   A. Arrange for inspection of installed roof by roof membrane manufacturer’s representative.

3.03 ACCEPTANCE
   A. Roof will be accepted by Owner only after roof membrane manufacturer’s inspection and approval, and delivery of executed warranty to Owner.

END OF SECTION
PART 1 GENERAL

1.01 DESCRIPTION

A. Section includes:
   1. The surface preparation and painting requirements additional to that provided in the County Standard Specification 09900.

B. Related Sections
   1. Structural Steel – Section 05120
   2. Miscellaneous Metals – Section 05500
   3. Basic Mechanical Materials and Methods – Section 15050
   4. Pipe and Fittings – Section 15075
   5. Valves and Appurtenances – Section 15076
   6. Valve Actuators – Section 15078

1.02 QUALITY ASSURANCE

A. Comply with applicable portions of General Provisions and Section 15050.
B. Provide components that are the standard product of a manufacturer regularly engaged in the production of the required materials and equipment.
C. A single manufacturer shall provide all paint products and appurtenances.
D. Use only experienced applicators to apply all paint and coating materials.
E. Only apply paint and coating materials when ambient temperature is 60 degrees F or higher and when surfaces are free from surface moisture unless otherwise allowed by the paint manufacturer.
F. Comply with applicable standards including, but not limited to the most recent edition of the following:
   1. Steel Structures Painting Council (SSPC)
      a. VIS1 – Pictorial Surface Preparation Standards
      b. SP1 – Solvent Cleaning
      c. SP2 – Hand Tool Cleaning
      d. SP3 – Power Tool Cleaning
      e. SP5 – White Metal Blast Cleaning
      f. SP6 – Commercial Blast Cleaning
      g. SP7 – Brush-off Blast Cleaning
      h. SP10 – Near-White Metal Blast Cleaning
      i. SP11 – Power Tool Cleaning to Bare Metal
      j. PA1 – Shop, Field, and Maintenance Painting
      k. PA2 – Paint Thickness Measurement
   a.  D4258 – Standard Practice for Surface Cleaning Concrete for Coating
   b.  D4259 – Standard Practice for Abrading Concrete
   c.  D4260 – Standard Practice for Acid Etching Concrete
   d.  D4261 – Standard Practice for Surface Cleaning Concrete Unit Masonry Coating
   e.  D4262 – pH of Chemically Cleaned or Etched Concrete Surfaces
   f.  D4263 – Indicating Moisture by the Plastic Sheet Method.

3.  National Association of Corrosion Engineers (NACE)
   a.  RP0188 – Discontinuity (Holiday) Testing of Protective Coatings

G. Select coating systems to provide satisfactory performance under the specified operating conditions.

1.03 SUBMITTALS

A.  Comply with Section SP-09. Include the following information:

1.  Manufacturer’s catalog information that describes each type of paint system provided. Include:
   a.  Specifications
   b.  Percent solids by volume
   c.  Minimum and maximum recommended dry film thickness per coat for primer, intermediate, and finish coats.
   d.  Recommended surface preparation
   e.  Recommended thinners
   f.  Statement for each painting system provided certifying that all coats in a painting system are compatible.
   g.  Application instructions with equipment recommendations and temperature limitations.
   h.  Statement certifying that coatings in contact with water are NSF61 compliant.

2.  Samples
   a.  Submit one (1) sample for each color, type of paint, and finish required.
      (1)  Make sample 8-inches by 10-inches
      (2)  Present on same materials as the finished facility
      (3)  Engineer will retain approved samples and use them to evaluate the actual work provided.
   b.  A painted “mock-up” panel may be submitted in lieu of samples.
      (1)  Minimum panel size of approximately 9 square feet or as directed by the Engineer.
      (2)  Obtain Engineer’s approval prior to proceeding with remaining work.
c. Submit paint samples to County for testing when directed by the Engineer.
   (1) Provide one quart samples.
   (2) Mark to identify the material designation, batch number, manufacturer’s order number, date of manufacture, and date of sampling.
   (3) Allow a minimum of seven days for testing.
   (4) Immediately remove rejected paint from the project site.

B. Submit applicator’s qualifications for approval. Provide:
   1. Name and experience record.
   2. List of utility or industrial installations painted by the applicator. Include:
      a. Responsible official, architect, or engineer.
      b. List approximate contract price.
   3. Demonstrate that the proposed applicator has at least five years experience preparing surfaces for painting in conformance with SSPC standards.
   4. Demonstrate that the proposed applicator has at least five years experience mixing and applying industrial coatings similar to those being used on this project.

C. Submit a detailed work schedule for all field cleaning, preparation and painting.
   1. Identify each painting system as a separate task.
   2. Do not begin any field painting until the Engineer approves the schedule.

1.04 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Deliver, handle, and store the equipment in accordance with Section SP-14.

B. Deliver material to the project site in the manufacturer’s original containers with labels intact and legible and the seals unbroken. Include the following information with each shipment:
   1. Manufacturer’s name.
   2. Product name or title.
   3. Color name and number.
   4. Manufacturer’s stock number and date of manufacture.
   5. Major pigment and vehicle constituent content by volume.
   6. Thinning instructions where allowed.
   7. Application instructions.

C. Material storage
   1. Store materials on site in a suitable location. Keep area clean and accessible.
   2. Maintain the storage area temperature between 65 degrees F and 90 degrees F at all times, unless other storage temperatures are required by the paint manufacturer.
   3. Comply with applicable health, fire and safety regulations.
   4. Provide approved fire extinguishers in the coating storage area.
PART 2 PRODUCTS

2.01 MANUFACTURERS
   A. Tnemec Company, Inc.
   B. Porter Paints / PPG
   C. Or equal.

2.02 GENERAL
   A. Use material produced by a single manufacturer for all painting systems specified. Use
      thinners and additives recommended by that manufacturer for each particular painting
      system.
   B. Coated surfaces in contact with water anywhere in the treatment process must comply
      with ANSI/NSF 61.
   C. Use only pre-tinted paints. Do not tint paint on site unless approved by the Engineer.
   D. Ensure that the prime and finish coats are compatible. A barrier coat may be used with
      the Engineer’s approval between factory applied prime coats and finish coats or when
      existing surfaces are to be refinished in the field.
   E. The County will select the colors to be used.
      1. Tint undercoats to match the finish coat.
      2. Tint each undercoat a lighter shade to distinguish between multiple coats of the
         same material.
   F. Use only lead and chromate free products in all coating systems, abrasives, cleansers
      and pigments.
   G. Comply with applicable Laws and Regulations limiting Volatile Organic Compound (VOC)
      emissions.
   H. Select coatings to ensure the color of the painted surface remains free from serious
      variations and fading for a period of at least five (5) years.
      1. No evidence of blistering, peeling, running, sealing, streaks, or stain at the end of
         the guarantee period.
      2. Washing painted surfaces with alkali free soap and water will remove dirt without
         causing the paint finish to deteriorate.

2.03 PAINT SYSTEMS
   A. System No. 1
      1. Use for metal structures, equipment and piping submerged in raw water,
         wastewater, alkaline waste or acidic waste (pH between 5 and 11).

<table>
<thead>
<tr>
<th>SURFACE PREPARATION</th>
<th>TNEMEC</th>
<th>PORTER</th>
<th>Min. DFT</th>
</tr>
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<tbody>
<tr>
<td>Ferrous Metals</td>
<td>SSPC – SP10</td>
<td>SSPC – SP5</td>
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<td>Non-Ferrous Metals</td>
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<td>SSPC – SP1</td>
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<td>FINISH COATS</td>
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<tr>
<td>1st Coat</td>
<td>Series N140 or N140F-1211</td>
<td>Aquapon 95-132</td>
<td>3.0 to 5.0</td>
</tr>
</tbody>
</table>
### A. System No. 1

1. Use for metal structures, equipment and piping subject to chemical fumes, direct chemical contact, salt spray, continuous condensation, intermittent immersion and splashing, or a severely corrosive environment. This applies primarily to the Flocculator, Lime/Chemical Feed, and Chlorine Feed areas of the Broad Creek II WTP.

### B. System No. 2

1. Use for metal structures, equipment and piping subject to chemical fumes, direct chemical contact, salt spray, continuous condensation, intermittent immersion and splashing, or a severely corrosive environment. This applies primarily to the Flocculator, Lime/Chemical Feed, and Chlorine Feed areas of the Broad Creek II WTP.

<table>
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<tr>
<th>2nd Coat</th>
<th>Series N140 or N140F-1255</th>
<th>Aquapon 95-132</th>
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<tr>
<td>3rd Coat</td>
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<td><strong>11.5 to 17.0</strong></td>
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<tr>
<td>1st Coat</td>
<td>90-97 Tneme-Zink</td>
<td>UC 65167 Series MC2inc</td>
<td>2.5 to 3.5</td>
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<tr>
<td>2nd Coat</td>
<td>N69-Color Hi-Build Epoxoline II</td>
<td>Pitthane Ultra</td>
<td>3.0 to 5.0</td>
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<tr>
<td>3rd Coat</td>
<td>V73 Color Endura-Shield</td>
<td>Pitthane Ultra</td>
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<tr>
<td><strong>Total</strong></td>
<td></td>
<td></td>
<td><strong>7.5 to 11.5</strong></td>
</tr>
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</table>

### C. System No. 3

1. Use for exterior exposed metal piping subject to ambient conditions. This applies primarily to the 20-inch DIP filter influent pipe.

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<th>Min. DFT</th>
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<td>UC 65167 Series MC2inc</td>
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<td>2nd Coat</td>
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<td>Pitthane Ultra</td>
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<tr>
<td>3rd Coat</td>
<td>V73 Color Endura-Shield</td>
<td>Pitthane Ultra</td>
<td>2.0 to 3.0</td>
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<tr>
<td><strong>Total</strong></td>
<td></td>
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<td><strong>7.0 to 11.0</strong></td>
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</table>
D. System No. 4
1. Use on buried metal surfaces such as valves, flanges and structural steel. Also use to repair factory pipe coatings.

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E. System No. 5
1. For use where metal is in direct contact with concrete. This applies to aluminum grating and handrail, stairs, structural members, wall castings, wall sleeves, and similar items throughout the plant.

2.

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<th>Min. DFT</th>
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<td>46H Hi-Build Tneme-Tar</td>
<td>PorterTuf 2000</td>
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<td>16.0 to 19.0</td>
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</table>

F. System No. 6
1. For use on exterior architectural concrete and cement plaster with a flat finish. This applies to areas throughout the plant.

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<th>PORTER</th>
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<td>1st Coat</td>
<td>151-1051 Elasto-Grip</td>
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<td>156-color Enviro-Crete</td>
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<td>5.0 to 10.5</td>
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</table>
G. System No. 7

1. For use on exterior architectural metal with a semi-gloss finish. This applies to structural members, metal supports, anchors, door frames, lintels, etc.

2.

<table>
<thead>
<tr>
<th></th>
<th>TNEMEC</th>
<th>PORTER</th>
<th>Min. DFT</th>
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<td>1&lt;sup&gt;st&lt;/sup&gt; Coat</td>
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<td>94-109 Epoxy Fast Dry</td>
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<td>Pittthane SemiGloss 95-8800</td>
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<td><strong>Total</strong></td>
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<td><strong>7.0 to 11.0</strong></td>
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3.

H. System No. 8

1. For use on interior unprimed architectural metal with a semi-gloss finish. This applies to lintels, exposed miscellaneous plate, etc.

<table>
<thead>
<tr>
<th></th>
<th>TNEMEC</th>
<th>PORTER</th>
<th>Min. DFT</th>
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<tr>
<td>SURFACE PREPARATION</td>
<td>SSPC – SP6</td>
<td>SSPC – SP6</td>
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<tr>
<td>FINISH COATS</td>
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<tr>
<td>1&lt;sup&gt;st&lt;/sup&gt; Coat</td>
<td>N69-Color Hi-Build Epoxoline II</td>
<td>95-245 RapidCoat DJR</td>
<td>3.0 to 5.0</td>
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<tr>
<td>2&lt;sup&gt;nd&lt;/sup&gt; Coat</td>
<td>N69-Color Hi-Build Epoxeline II</td>
<td>97-130 Aquapon</td>
<td>4.0 to 6.0</td>
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<td><strong>Total</strong></td>
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<td><strong>7.0 to 11.0</strong></td>
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PART 3 EXECUTION

3.01 GENERAL

A. Receive, open, and mix all paint in a designated area that is kept clean and neat.

1. Remove and dispose of empty containers, wipe cloths, and other debris at the end of each day’s work.

2. Close all partially used containers.

3. Take all necessary precautions to prevent fire.

B. Do not paint in the rain, wind, snow, mist, or fog, or when metal surface temperatures are less than 5 degrees F above the dew point.

C. Do not paint when the relative humidity is greater than 85 percent.

D. Paint only when ambient conditions conform to the paint manufacturer’s recommendations.
E. Perform all exterior painting during daylight hours.
F. Do not apply the finish coat until other adjacent work is completed, the heating and ventilation system is fully operational, and all doors, windows and glazing are in place.
G. Do not sandblast PVC, CPVC or FRP pipe and equipment or pipe and equipment that has a factory applied epoxy or enamel coating.
H. Protect adjacent surfaces by using drop cloths, masking, fixture removal or other approved measures.
   1. Protect the working parts of mechanical and electrical equipment.
   2. Do not paint over equipment nameplates.
   3. Protect newly painted surfaces from contamination and overspray.
   4. Repair damage at no cost to the Owner.
I. Provide painted surfaces that are free from runs, drips, ridges, waves, laps, and brush marks; and that do not vary in color, texture or finish.

3.02 PREPARATION
A. Ensure that the moisture content of surfaces to be painted conform to the manufacturer’s recommendations.
B. Clean and prepare surfaces to receive paint and protective coatings as specified prior to applying any coating material.
C. Examine surfaces to be coated.
   1. Report any condition that would adversely affect the coating system appearance or performance.
   2. Beginning work indicates acceptance of the substrate.
D. Restore marred or abraded areas on shop primed and factory finished surfaces prior to applying additional coatings.
E. If blast cleaning is necessary and portions of the area or assembly have been previously coated, remove prior coatings to the extent necessary to ensure proper adhesion of the specified coating.
F. Concrete and masonry surfaces
   1. Do not begin surface preparation until the concrete and masonry has cured for at least 28 calendar days.
   2. Test the surfaces to be painted for moisture content in accordance with ASTM – D4263.
   3. Clean the surfaces in accordance with ASTM D4258.
   4. Prepare the surfaces for painting in accordance with ASTM D4259 and D4260, as applicable. For concrete in immersion service:
      a. Remove all laitenance and loose material.
      b. Open up air entrained honeycombs and bug holes and make them concave in shape.
      c. Use abrasive sweep blasting to develop a surface profile comparable to 60 to 80 grit sandpaper.
      d. Take care to minimize aggregate exposure.
e. Patch holes and other imperfections using Tnemec 280 and Tnemec 280 part C fumed silica additive or a non-cementious compound recommended by the paint manufacturer. Add sufficient Tnemec 280 part C to achieve a drywall mud consistency.

f. Dry surfaces and ensure they are free of alkalis prior to painting.

G. Lightly abrade the surface of PVC, CPVC, FRP and fusion bonded epoxy with medium grain sand paper or as recommended by the paint manufacturer prior to painting.

H. Fill and seal nail holes, cracks, scratches, abrasions, and knots on all wood surfaces. Sand the surfaces and remove dust prior to painting.

I. Gypsum wallboard
   1. Sand joints smooth
   2. Feather the edges
   3. Remove dust prior to painting.

3.03 ITEMS NOT TO BE COATED

A. Hardware and hardware accessories
B. Equipment name tags and data plates
C. UL, FM and similar labels.
D. Machined surfaces
E. Equipment (including instrumentation) with factory finishes.
F. Mating friction surfaces in structural steel.
G. PVC pipe unless otherwise noted.
H. Galvanized and stainless steel unless otherwise required by the Contract Documents.

3.04 APPLICATION OF PROTECTIVE COATINGS

A. General
   1. Equipment and fabricated metal work may be shop primed with the specified coating in lieu of priming in the field.
      a. Do not shop prime with an unauthorized coating system.
      b. Remove unauthorized shop coats and apply the specified coating in the field at no additional cost to the County.
      c. Manufactured equipment with approved corrosion-resistant finishes and galvanized finishes are exempt from the stripping requirement.
   2. Apply protective coating within 8 hours of completing surface preparation or prior to a rust bloom forming, whichever occurs first. Repeat surface preparation on any surface showing traces of rust prior to coating application.
   3. Remove or mask all items that are not to be painted but that contact painted surfaces prior to surface preparation. Reinstall items after painting is complete.
   4. Apply coatings with brush, roller, air spray or air-less spray unless otherwise required by the paint manufacturer.
      a. The use of spray painting must be approved by the Owner.
      b. Use brushing in those areas that are inaccessible to spray coating or rolling.
c. Use only good quality brushes and accessories that are appropriate for the system being applied.

5. Ensure that all surfaces including but not limited to edges, corners, crevices, welds, and bolts receive at least the specified dry film coating thickness.

6. Use drop cloths to protect floors, fixtures, and equipment.
   a. Prevent paint from being spattered onto surfaces from which the paint cannot be removed.
   b. Re-paint areas that have been paint spattered as required by the County.

B. Paint Mixing

1. Mix paint by mechanical means and use all paint directly from the manufacturer’s original containers.
   a. Only tinting materials may be added to the paint. Do not thin the paint or add other materials unless approved by the Engineer.
   b. Do not leave paint in spray pots or painter’s buckets overnight. Return to original container and remix before using.

2. Prepare multiple component coatings using the entire contents of each container for each component as packaged by the paint manufacturer.
   a. Do not mix partial batches.
   b. Do not use multiple component coatings that have been mixed beyond their pot life.
   c. Provide small quantity kits for touch up and for small areas.
   d. Do not intermix additional components for any reason, even if the additional components are within the same generic type of coating.

3. Use only the thinner recommended by the manufacturer.

4. Do not use paint that is beyond its shelf or pot life.

C. Paint Application

1. Comply with the manufacturer’s instructions and recommendations.
   a. Spread material evenly and smoothly without runs, sags, or other defects.
   b. Use a series of small circular painting strokes to fill surface irregularities and then use parallel strokes.
   c. Apply finish coats vertically on all vertical surfaces.
   d. Do not lap paint on adjacent surfaces.
   e. Apply coatings to sharply cut lines.

2. Apply coatings in a dry, dust-free environment.

3. Do not apply coatings:
   a. To wet or damp surfaces
   b. During periods of rain, fog or mist
   c. When the relative humidity exceeds 85 percent.
   d. When the air temperature is predicted to drop below 40 degrees F within 18 hours after applying the coating.
4. Do not apply the finish coat to piping until the piping has been tested and approved.

5. Complete the day’s coating applications prior to the time of day when condensation is likely to occur.

6. Paint all exposed surfaces. Coat surfaces that will be inaccessible after assembly before erection. This requirement does not apply to structural friction connections or high strength bolts and nuts.
   a. Hand or power tool clean areas damaged during erection.
   b. Re-coat with the specified prime coat.

7. Touch up surfaces after installation and erection.

8. Allow sufficient drying time between each coat.
   a. Sand surfaces between coats as necessary to produce a smooth finish.
   b. Once recoating begins, complete the entire coating application without interruption and delay.

9. Verify that the specified dry film thickness has been achieved after each coat.

3.05 FIELD QUALITY CONTROL AND TESTING

A. Perform field inspection and testing in accordance with Section 01650.

B. Thickness testing
   1. Collect at least one thickness measurement for every twenty square feet of coated area. Mark and re-coat:
      a. Whenever any single reading less than 20 percent below the minimum specified DFT.
      b. When the average of all areas is outside of the specified DFT.

   2. Measure ferrous surfaces with a magnetic type dry film thickness gauge.


   4. Test all non-metallic surfaces with a Tooke gauge. Repair Tooke gauge cuts using the specified primer and top coat.

C. Holiday testing
   1. Test all System No. 1, 2 and 3 coatings (metals in immersion service) with a Holiday detector.
      a. Use a low voltage, wet-sponge type detector for systems with a total thickness less than 20 mils. Add a non-sudsing agent to the water when the thickness is between 10 and 20 mils.
      b. Use a high voltage detector when the coating thickness is greater than 20 mils.

   2. Conduct all tests in accordance with NACE RP0188.

D. Coating repairs
   1. Improper finish color or insufficient dry film thickness.
      a. Clean and topcoat the surface with the specified paint material.
      b. Obtain the specified color and coverage.

   2. Field touch-up of shop applied prime coats:
a. Use an organic zinc primer for those surfaces that are shop primed with an inorganic zinc primer.
   (1) Cover all scratches or abraded areas.
   (2) Use only organic zinc coating systems with a minimum solids volume of 32 percent, a minimum zinc content of 15 pounds per gallon and primers of the converted epoxy or epoxy phenolic type.

b. Use the same primer as in the original prime coat for other surfaces.

3. Hand or power-sand visible areas of chipped, peeled, or abraded paint. Feather the edges.

4. Apply coatings so that they are free of runs, bridges, shiners, laps or other imperfections.

E. Cleanup

1. Remove staging, scaffolding, paint containers, and application tools from the site upon completing the work.

2. Leave all surfaces clean and free from any paint, stain, smears, spattering, or smudges.

END OF SECTION
SECTION 10200
LOUVERS

PART 1 GENERAL

1.01 DESCRIPTION
   A. This section includes requirements for providing fixed louvers, and screens.

1.02 QUALITY ASSURANCE
   A. Obtain louvers from a single source.
   B. Design, engineer, fabricate, and install exterior metal wall louvers to withstand the effects of loads and stresses from wind and normal thermal movement, without evidencing permanent deformation of louver components including blades, frames, and supports; noise or metal fatigue caused by louver blade rattle or flutter; and permanent damage to fasteners and anchors.

1. Wind Load shall conform to a uniform pressure (velocity pressure) of 20 pounds force per square foot acting inward or outward.

2. Normal thermal movement is defined as that resulting from the following maximum change in ambient temperature. Base design calculations on actual surface temperatures of metals due to both solar heat gain and nighttime sky heat loss. Temperature Change shall be 100 degrees F (55.5 degrees C).

C. Provide louvers complying with air performance, water penetration, and air leakage ratings performance requirements indicated as demonstrated by testing manufacturers stock units, of height and width indicated, according to Air Movement and Control Association (AMCA) Standard 5.

1.03 SUBMITTALS
   A. Submit shop drawings as specified in the Section SP-09.
   B. Provide shop drawings of louver units and accessories. Include plans, elevations, sections, and details showing profiles, angles, spacing of louver blades; unit dimensions related to wall openings and construction; free areas for each size indicated; and profiles of frames at jambs, heads and sills.

1. Where installed products are indicated to comply with certain structural design loadings, include structural computations, material properties, and other information needed for structural analysis which has been prepared by, or under the supervision of, a qualified professional Engineer.

C. Provide product test reports evidencing compliance of units with performance requirements indicated.

D. Provide product certificates signed by louver manufacturers certifying that their products which comply with Project requirements are licensed to bear AMCA Seal based on tests made in accordance with AMCA Standard 500 and complying with AMCA Certified Ratings Program.

E. Submit certification that all dimensions and depths of louvers are satisfactory for use in the specified locations.

PART 2 MATERIALS

2.01 MANUFACTURERS
   A. Available manufacturers shall be subject to compliance with requirements, manufacturers offering products which may be incorporated in the work include, but are not limited to, the following:
2.02 Fixed Louvers
A. Construction Specialties, Inc. model 3157
B. Ruskin
C. Or Equal

2.03 Louver performance criteria shall be based on physical data indicated on the contract drawings. Testing data shall be based on tests performed in accordance with AMCA Standard 500.

2.04 Aluminum Finishes
A. Finish designations prefixed by "AA" conform to the system established by the Aluminum Association for designating aluminum finishes.
B. The high performance organic coating shall be the Fluorocarbon 2-Coat Coating Systems using the manufacturer's standard 2-coat thermo-cured system, composed of specially formulated inhibitive primer and fluorocarbon color topcoat containing not less than 70 percent polyvinylidene resin by weight; complying with AAMA 605.2. Paint and coatings shall conform to Section 09900.

2.05 Fixed Louvers
A. Provide double drainable fixed extruded louvers.
B. Louvers shall be fabricated from aluminum extrusions, designed to collect and drain water to exterior at sill by means of gutters in front edges of blade and of channels in jambs and mullions, complying with the following requirements:
   1. Louver depth shall be coordinated with wall thickness.
   2. The louver frame shall be one piece structural member of 6063-T52 Alloy, 0.064" thick with interior caulking slow and retaining beads.
   3. Mullions shall be sliding interlock type with integral drain.
   4. Fixed blade thickness shall be 0.064 inch.
   5. Fasteners shall be stainless steel or aluminum.
   6. Structural supports shall be designed to carry a wind load of not less than 20 pounds per square foot.
   7. Louver performance criteria shall be based on physical data indicated in items (1) and (2) below, and testing data based on louver in accordance with AMCA Standard 500 and shall be used as a basis for selection of the louvers to be provided.
      a. Louver free area = 7.70 square feet
      b. Percent free area = 48.1
      c. Free are velocity at the point of beginning water penetration (.02 oz./square foot) = 835 fpm.

2.06 Louver Screens
A. Provide louvers with screens at locations scheduled on the drawings.
   1. Screen Locations for fixed Louvers shall be on the interior face.
   2. Secure Location for Adjustable louvers shall be on the interior face.
   3. Secure screens to louver frames with stainless steel machine screws, spaced at each corner and at 12 inch o.c. in be
   4. Fabricate screen frames with mitered corners to louver sizes indicated.
a. Metal shall be the same kind and form of metal as indicated for louver frames to which screens are attached. Reinforce extruded aluminum screen frames at corners with clips.

b. The finish shall be the same finish as louver frames to which louver screens are attached.

c. Provide rewireable frames with a driver spline or insert for securing screen mesh.

5. Fit aluminum louver screen frames with screening covering louver opening and complying with the following requirements:

a. Bird Screening shall be ½ inch square mesh formed with 0.063 inch diameter aluminum wire.

b. Insect screening shall be 18mm x 14mm aluminum mesh formed with 0.0123 inch diameter aluminum wire.

2.07 Blank-Off Panels

A. Fabricate blank-off panels from materials specified and to sizes indicated.

1. The finish shall match finish applied to louvers with respect to coating type, color, and gloss.

2. Attach blank-off panels to back of louver frames with stainless steel sheet metal screws.

B. Insulated blank-off panels shall be fabricated from laminated metal-face panels consisting of insulating core surfaced on back and front with metal sheets; complying with the following requirements:

1. The thickness shall be 1 inch.

2. Metal facing sheets shall be aluminum sheet, 0.032 inch thick.

3. Insulating core shall be extruded polystyrene insulation board insulation complying with ASTM C 578, Type VII (2.2 lb/cu. Ft. density).

4. Trim perimeter edges of blank-off panels with louver manufacturer’s standard extruded aluminum channel frames 0.081 inch thick, with corners mitered and with same finish as panels.

2.08 Aluminum Finishes

A. Finish designations shall conform to the system established by the Aluminum Association for designating aluminum finishes.

B. The high performance organic coating shall be the Fluorocarbon 2-Coat Coating Systems using the manufacturer’s standard 2-coat thermo-cured system, composed of specially formulated inhibitive primer and fluorocarbon color topcoat containing not less than 70 percent polyvinylidene resin by weight; complying with AAMA 605.2.

C. Color and gloss shall be PPG Duranar Low Gloss, color to be selected by Owner’s Representative.

PART 3 EXECUTION

3.01 PREPARATION

A. Coordinate setting drawings, diagrams, templates, instructions and directions for installation of anchorages which are to be embedded in concrete or masonry construction. Coordinate delivery of such items to project site.
3.02 FABRICATION

A. Fabricate louvers and vents to comply with requirements indicated for design, dimensions, materials, joinery, and performance.

B. Pre-assemble louvers in shop to minimize field splicing and assembly. Disassemble units as necessary for shipping and handling limitations. Clearly mark units for reassembly and coordinated installation.

C. Maintain equal louver blade spacing, including separation between blades and frames at head and sill, to produce uniform appearance.

D. Fabricate frames, including integral sills, to fit in openings of size indicated with allowances made for fabrication and installation tolerances of louvers, adjoining construction, and perimeter sealant joints.

E. Include supports, anchorages, and accessories required for complete assembly.

F. Provide vertical mullions of type and at spacings indicated but not further apart than recommended by manufacturer, or 72 inches o.c., whichever is less. At horizontal joints between louver units provide horizontal mullions except where continuous vertical assemblies are indicated.

G. Provide sill extensions and loose sills made of same material as louvers, where indicated, or required for drainage to exterior and to prevent water penetrating to interior.

3.03 INSTALLATION

A. Locate and place louver units plumb, level, and in proper alignment with adjacent work.

B. Use concealed anchorages where possible. Provide brass or lead washers fitted to screws where required to protect metal surfaces and to make a weather-tight connection.

C. Form closely fitted joints with exposed connections accurately located and secured.

D. Provide perimeter reveals and openings of uniform width for sealants and joint fillers, as indicated.

E. Repair finishes damaged by cutting, welding, soldering, and grinding operations required for fitting and jointing. Restore finishes so there is no evidence of corrective work. Return items which cannot be refinished in field to shop, make required alterations and refinish entire unit, or provide new units.

F. Install concealed gaskets, flashings, joint fillers, and insulation, as louver installation progresses where required to make louver joints weather-tight.

G. Jamb gasket shall be provided as the gasket between blade ends and louver jamb.

H. CONTRACTOR shall coordinate size, locations requirements with structural and architectural work prior to submitting.

END OF SECTION
SECTION 11010
SUPERPULSATOR CLARIFIER SYSTEM

PART 1 GENERAL

1.01 DESCRIPTION
A. Provide one high-rate pulsating sludge blanket clarifier to flocculate and settle ferric hydroxide.
B. In general include the clarifier with the following components, as specified herein:
  1. Vacuum chamber equipment
  2. Vacuum pumps
  3. Raw water distribution pipes
  4. Settling plates and supports
  5. Clarified water collectors
  6. Sludge extraction system
  7. Air Compressor
  8. Sampling sink and appurtenances
  9. All necessary valves and controls to comprise a complete operational system.
C. Design the clarifier basins such that tube-settling modules may be installed above the settling plates in the future, if needed.

1.02 QUALITY ASSURANCE
A. Comply with applicable portions of Section 15050 and the General Provisions.
B. Manufacturer's Experience:
  1. Minimum of 10 years experience in design and supply of up-flow, high-rate pulsating clarifiers.
  2. Provide list from equipment manufacturer of ten similar size installations utilizing up-flow, high-rate pulsating clarifiers.
C. Comply with applicable standards.
D. Provide all components be suitable for contact with drinking water, per National Science Foundation (NSF)/American National Standards Institute (ANSI) Standard 61 – Drinking Water System Components.

1.03 SUBMITTALS
A. Provide shop drawings, samples, administrative, quality control, and contract closeout submittals in accordance with the SP-09 and as listed below:
  1. Manufacturers literature, illustrations, specifications and engineering data including dimensions, materials, size, weight, and performance data for all components.
  2. Manufacturer's installation instructions.
  3. Details for vacuum pumps, including:
     a. Design calculations supporting size selection.
b. Curves showing overall efficiencies and flow rate, brake horsepower and motor horsepower.

4. Details for raw distribution pipes, including:
   a. Materials of construction
   b. Pipe supports and spacing
   c. Information on sizing of laterals
   d. Overall layout drawing

5. Details for settling plates and supports, including:
   a. Overall layout drawing and section
   b. Details of connection at support points.

6. Details for clarified water and sludge collectors, including:
   a. Overall layout drawing
   b. Materials of construction
   c. Pipe supports and spacing
   d. Information on sizing of laterals and perforations
   e. Motor operator and controls for plug valves on sludge withdrawal piping.

7. Control Panel
   a. Shop Drawings:
      (1) Instrumentation and control system schematics, tubing and conduit details, and wiring diagrams for electrical and control components furnished.
      (2) Any necessary dimensioned drawings to coordinate piping layout with structural, architectural, electrical and/or other mechanical work.
      (3) Certified drawings of the local control station and master control panels.
      (4) Cut sheet of all equipment and devices provided as part of the system.
   b. Process Control and Instrumentation:
      (1) Complete system block diagram with all inter-equipment wiring and conduit requirements.
      (2) Point-to-point interconnection wiring diagrams, indicating field instrumentation and control panel connections.
      (3) Panel wiring, conduit diagrams, and input/output (I/O) modules layout.
      (4) English-language loop descriptions.
      (5) Instrument index with ranges and set points.
      (6) Fully documented ladder logic programmable logic controller (PLC) program listing including the I/O list and housing configuration for each PLC. Provide an electronic file of documented PLC programs.
(7) Copies of all proposed database, for an integration with the Plant PLC and existing digital control system (DCS) system.

(8) Detailed factory testing procedure.

(9) Detailed electrical schematics and layout drawings including interior panel layout, detailed interface and interconnection drawings indicating interlock signals, terminal connections, field instrumentation, electrical device sizing such as fuses, circuit breakers, etc.

8. Detailed description of operation.

9. List of manufacturer’s recommended parts required to maintain the equipment for a period of one year, with current price information.

10. List of special tools, materials, and supplies furnished with the equipment for use prior to and during startup, and for future maintenance.

11. Any additional information to demonstrate compliance with these specifications.

B. Submit Operation and Maintenance Manuals in accordance with Section SP-10.

C. Submit manufacturer’s certificates in accordance with the Section SP-08.

1.04 DELIVERY, STORAGE AND HANDLING

A. Deliver, handle, and store the equipment in accordance with Section SP-13.

1.05 SPECIAL TOOLS AND SPARE PARTS

A. Furnish one set of all special tools required to disassemble, service, repair, and adjust the equipment and appurtenances.

1.06 SYSTEM AND EQUIPMENT PATENTS

A. Include all royalty and license fees for use of patented devices or systems, if any.

B. Protect the Owner and Engineer from patent infringement litigation thereon.

PART 2 PRODUCTS

2.01 GENERAL

A. Provide one high-rate Superpulsator system per the following design criteria:

1. Design Capacity: 2,800 gallons per minute (gpm)

2. Loading Rate: 2.3 (gallons per minute per square foot) gpm/ft²

2.02 SYSTEM MANUFACTURER

A. Infilco Degremont, Inc. (IDI).

B. If Contractor wished to furnish an alternate system manufacturer, Contractor shall first make written application to Engineer for acceptance thereof, certifying that the proposed substitute will perform adequately the functions and achieve the results called for by the general design, be similar in substance to that specified and be suited to the same use as that specified. The application will also contain an itemized estimate of all costs or credits that will result directly or indirectly from acceptance of such substitute, including costs of redesign and claims of other contractors affected by the resulting change, all of which will be considered by Engineer in evaluating the proposed substitute.

2.03 VACUUM CHAMBER EQUIPMENT

A. Equip vacuum chamber with:
1. Vent valve assembly consisting of a 6-inch vacuum release eccentric plug valve with pneumatic operator and 4-way solenoid actuator.
2. Type 304 stainless steel (SS) piping, fittings and vent screens and discharge for the installation of the vent release valve.
3. One 30-inch aluminum access manway and aluminum ladder.
4. A sight tube assembly consisting of ¾-inches Schedule 80 clear pipe, threaded fittings and wall sleeves.

B. Minimize vortexing and turbulence in the vacuum chamber through the installation of a 24-inch diameter vortex breaker on the top of the vertical influent pipe.

2.04 VACUUM PUMPS AND PIPING
A. Provide two vacuum pumps, one duty and one spare including outlet silencer and as specified.
   1. Pump Type: Centrifugal
   2. Manufacturer: Spencer – VB037 or equal
   3. Power: 5 hp
   4. Motor Type: premium efficiency
      460-volt, 3-phase, 60 hertz, totally enclosed and fan cooled (TEFC)
   5. Motor Service Factor: 1.15
B. Provide interconnecting 3-inch-diameter 304 SS piping and tubing from the vacuum tank to the pumps.
C. Provide three manual butterfly valves for pump isolation and one air bleed valve to regulate the speed of vacuum.

2.05 RAW WATER DISTRIBUTION PIPING
A. Provide perforated laterals from raw water distribution channel as shown in Contract Drawings.
B. Provide lateral pipes of:
   1. Length: 20 feet
   2. Diameter: 12 inches
   3. Spacing: 3 feet, 4 inches (center to center)
   4. Material: Schedule 40 polyvinyl chloride (PVC)
C. Provide pipe laterals preassembled with end caps and orifices by the manufacturer, and pipe supports.
D. Provide PVC couplings as wall fittings for receiving distribution laterals.
E. All mounting hardware shall be 304 SS.

2.06 SETTLING PLATES AND SUPPORTS
A. Provide a series of inclined plate modules positioned over the distribution laterals at a spacing of 11 inches.
B. Attach horizontal deflectors to the underside of the plates to generate a vertical flow pattern within the settling plate modules.
C. Provide plate modules of 1/16-inches-thick fiber-reinforced plastic (FRP) of suitable stiffness to be self-supporting when placed on horizontal support angles which also act as deflectors.

D. Provide aluminum horizontal support angles.

E. Anchor angles at the side walls with 304 SS anchor bolts.

F. Attach the fiberglass plates to the horizontal support angles with rubber grommets and stainless steel self-tapping screws.

G. Install a section of removable settling plates for access.

2.07 CLARIFIED WATER COLLECTORS

A. Provide a series of 12-inch-diameter and 20-feet-long Schedule 40 PVC perforated laterals.

B. Provide laterals preassembled with end caps and orifices by the Manufacturer.

C. Provide wall mounting hardware of 304 SS.

2.08 SLUDGE EXTRACTION SYSTEM

A. Provide sludge extraction system composed sludge draw-off pipes and sludge concentrators.

B. Provide four sludge concentrators in the clarifier.

C. Equip each sludge concentrator with:
   1. A 3-inch sludge draw-off lateral supported off the concentrators using appropriate 304 SS wall brackets and/or pipe hangers.
   2. A 6-inch sludge draw-off header penetrating through the wall of the clarifier with appropriate fitting.
   3. Schedule 80 PVC piping with appropriate joints.

D. Provide PVC pipe headers with appropriate manual and automatic valves outside the basin.

E. Eccentric Plug Valves
   1. Provide four pneumatically actuated plug valves for sludge removal and four manual isolating plug valves with lever actuator for sludge header isolation.
   2. Provide actuators as per specification section 15078.

2.09 BASIN SAMPLING

A. Provide 3/4-inches-diameter Schedule 80 PVC piping and fittings for three sampling points, each with a manual ball valve.

B. Provide a cast epoxy sink at the location shown on the Drawings.

2.10 AIR COMPRESSOR

A. General:
   1. Rotary screw type.
   2. Pressure lubricated oil filled, reciprocating, dual-head type.
   3. Mounted on an American Society of Mechanical Engineers (ASME) designed air receiver tank.
   4. Minimum of 3.8 scfm at 100 psi.
5. Provide air compressor with Manufacturer Local Control Panel (LCP). LCP will enclose the main circuit breaker, motor starter, control relays, pressure switches.

6. Provide a low pressure normally open dry contact rated for 120 VAC, 5 amp for alarm indication to DCS.

B. Motor:
1. 460-volt, 3 phase, 60 hertz, 2.0 hp, TEFC motor.
2. Premium efficiency.
3. Class F insulation with a 1.15 service factor.

2.11 CONTROL PANEL
A. Clarifier Master Control Panel (MCP) and Local Control Station (LCS)
1. Provide a MCP and a LCS as shown on drawings.
2. Comply with Section 16946 for control panel and as specified herein.
3. Clarifier MCP
   a. Power requirement shall be 120 VAC, 3 Phase, 15 Amp.
   b. The MCP shall consist of main circuit breaker, a PLC, pilot light, selector switches, pushbutton, terminal blocks, fuse.
   c. The Clarifier MCP shall be a PLC based control panel with processor, I/O cards, communications interfaces, power supply and other components required for a complete, functioning of the clarifier control system. The PLC shall be a Micro PLC type. Comply with Section 16942 for PLC specifications.
   d. Door mounted lights, switches, and pushbutton.
   e. The following monitoring and control shall be performed at the PLC.
      (1) Monitor and control the automatic pulsing cycle.
      (2) Monitor and control frequency and duration of sludge extraction.
      (3) Operator selectable: timer or percentage of raw water flow.
      (4) When preset value is reached, initiate extraction sequence.
      (5) Open one draw-off valve at a time with slight delay in valve openings.
      (6) Terminate the sludge extraction at completion of timer-controlled sequence.
   f. Operation, monitoring and parameter configuration of the Clarifier PLC shall be performed from the Main Plant PLC through the Plant Operator Interface Terminals (OIT) or the existing DCS workstation.
   g. Provide inputs and outputs sufficient to interface with all panel and field mounted devices including a customer provided 4-20 mA signal for influent flow rate.
   h. The Clarifier manufacturer shall assist in the coordination and field testing of the data link between the MCP and the Plant PLC.
i. All PLC source code and configuration files shall be provided to the County prior to start-up. Provide one copy of the PLC programming software licensed to the County.

j. The Clarifier MCP shall communicate to the Main Plant PLC via Ethernet Network Cat5 shielded cable.

k. Provide MCP in a National Electrical Manufacturers Association (NEMA) 12 enclosure

4. LCS
   a. Provide a LCS at the vacuum pumps for local operation.
   b. Provide a NEMA 4X SST or FRP enclosure
   c. The following operation shall be perform locally at the Vacuum room:
      (1) Vacuum pump start/off/ test selector switch
      (2) Vacuum pump status pilot light
      (3) Sludge Blowdown valve test selector switch
      (4) Vacuum pump status pilot light
   d. The Control panel design, construction, and testing shall be completed in an International Organization for Standardization (ISO) 9001 certified shop by the clarifier manufacturer.
   e. Provide wire tags on every conductor. Provide slip-on or heat shrink sleeve markers. Tags using adhesives are unacceptable. Contractor shall use permanent mechanically applied labeling.

B. Replace the existing Clarifier system control panel for a MCP and a LCS similar to the ones specified above. Similar to the new Clarifier system, install the new MCP and LCS at the Control Panel Room and the existing Vacuum Pump room respectively.

2.12 Provide coordination with the Application Program Supplier (APS) and the ISS for the data to be transferred between the Clarifier and Plant PLCs and DCS.

2.13 INFLUENT/EFFLUENT WEIRS
   A. Provide two sets of 304 SS “C” channel weir plates, channel guide, gaskets and anchor bolts for influent flow and effluent collection channel level control.

PART 3 EXECUTION

3.01 INSTALLATION
   A. Install all materials and equipment in a neat, workmanlike manner.
   B. Install all equipment in accordance with the Manufacturer's recommendations and the Contract Documents.
   C. Install anchor bolts and other parts in concrete in accordance with Division 3.
   D. Prior to startup and field testing, remove all foreign matter from the equipment, inside the control panel (if required), and interconnecting piping.
   E. Clean all the spillage of lubricants used in servicing the equipment from pumps, piping, and concrete surfaces.

3.02 FIELD QUALITY CONTROL AND TESTING
   A. Perform field inspection and testing in accordance with the Section 01650.

3.03 MANUFACTURER’S FIELD SERVICES
A. Provide in accordance with the Section SP-18.
   1. Manufacturer's services provided by factory trained Engineer shall include
      inspect, start-up and training.

B. Provide manufacturer’s field services for ten (10) days in no more than three (3) trips to
   the job site.

END OF SECTION
SECTION 11020
GREENLEAF FILTER SYSTEM

PART 1 GENERAL

1.01 DESCRIPTION
A. Provide one Greenleaf filter system to filter the clarified water.
B. In general the filter components include the following, as specified herein:
   1. Center core siphon
   2. Annular flume and inlet siphons
   3. Operating platform assembly and vacuum system consisting of tank and pumps
   4. Walkway
   5. Spent filter backwash drains
   6. Effluent weir
   7. Filter underdrains, media, and wash troughs.
   8. Backwash control panel
   9. All necessary valves and controls to comprise a complete operational system.

1.02 QUALITY ASSURANCE
A. Comply with applicable portions of Section 15050 and General Provisions.
B. Manufacturer’s Experience:
   1. Minimum of ten years experience in design and supply of siphon filter systems.
   2. Provide list from equipment manufacturer of ten similar size installations utilizing siphon technology filters.
C. Comply with applicable standards.
D. Provide all components suitable for contact with drinking water, per NSF/ANSI Standard 61 – Drinking Water System Components.

1.03 SUBMITTALS
A. Provide shop drawings, samples, administrative, quality control, and contract closeout submittals in accordance with Section SP-09 and as listed below:
   1. Manufacturers literature, illustrations, specifications and engineering data including dimensions, materials, size, weight, and performance data for all components.
   2. Manufacturer’s installation instructions.
   3. Details for all filter components.
   4. Characteristics of the underdrain system, flumes, and filter media.
   5. Filter system backwash water, backwash air, and backwash water with air hydraulic calculations.
6. **Control Panel**
   a. **Shop Drawings:**
      1. Instrumentation and control system schematics, tubing and conduit details, and wiring diagrams for electrical and control components furnished.
      2. Any necessary dimensioned drawings to coordinate piping layout with structural, architectural, electrical and/or other mechanical work.
      3. Certified drawings of the local control station (LCS) and master control panel (MCP).
   b. **Process Control and Instrumentation:**
      1. Complete system block diagram with all inter-equipment wiring and conduit requirements.
      2. Point-to-point interconnection wiring diagrams, indicating field instrumentation and control panel connections.
      3. Panel wiring, conduit diagrams, and input/output (I/O) modules layout.
      4. English-language loop descriptions.
      5. Instrument index with ranges and set points.
      6. Fully documented ladder programmable logic controller (PLC) program listing including the I/O list and housing configuration for each PLC. Provide an electronic file of documented PLC Programs.
      7. Copies of all proposed operator interface screens and database, for an integration with the Plant PLC and existing digital control system (DCS).
      8. Detailed factory testing procedure.

7. List of manufacturer’s recommended parts required to maintain the equipment for a period of one year, with current price information.

8. List of special tools, materials, and supplies furnished with the equipment for use prior to and during startup, and for future maintenance.

9. Any additional information to demonstrate compliance with these specifications.

10. Detailed description of operation.

B. Submit Operation and Maintenance Manuals in accordance with Section SP-10.

C. Submit manufacturer’s certificates in accordance with Section SP-08.

1.04 **DELIVERY, STORAGE AND HANDLING**

A. Deliver, handle, and store the equipment in accordance with Section SP-14.

1.05 **SPECIAL TOOLS AND SPARE PARTS**

A. Furnish one set of all special tools required to disassemble, service, repair, and adjust the equipment and appurtenances.

1.06 **SYSTEM AND EQUIPMENT PATENTS**

A. Include all royalty and license fees for use of patented devices or systems.
B. Protect the Owner and Engineer from patent infringement litigation thereon.

PART 2 PRODUCTS

2.01 GENERAL

A. Provide one Greenleaf Filter System per the following design criteria:

1. Design Capacity: 2,778 gallons per minute (gpm)

2.02 SYSTEM MANUFACTURER

A. Infilco Degremont, Inc. (IDI).

B. If Contractor wished to furnish an alternate system manufacturer, Contractor shall first make written application to Engineer for acceptance thereof, certifying that the proposed substitute will perform adequately the functions and achieve the results called for by the general design, be similar in substance to that specified and be suited to the same use as that specified. The application will also contain an itemized estimate of all costs or credits that will result directly or indirectly from acceptance of such substitute, including costs of redesign and claims of other contractors affected by the resulting change, all of which will be considered by Engineer in evaluating the proposed substitute.

2.03 FILTER SYSTEM DESIGN CRITERIA

A. Filter Size and Construction:

<table>
<thead>
<tr>
<th>Description</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. of Filters:</td>
<td>1</td>
</tr>
<tr>
<td>No. of Cells per Filter:</td>
<td>4</td>
</tr>
<tr>
<td>Filter Cell Length (feet (ft))</td>
<td>14</td>
</tr>
<tr>
<td>Filter Cell Width (ft):</td>
<td>14</td>
</tr>
<tr>
<td>Area per Filter Cell (square feet (ft²))</td>
<td>171</td>
</tr>
<tr>
<td>Total Filter Area (ft²):</td>
<td>684</td>
</tr>
</tbody>
</table>

B. Filter Design Conditions:

<table>
<thead>
<tr>
<th>Condition</th>
<th>Minimum</th>
<th>Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Filtration rate (gallons per min per square feet (gpm/ft²)) (all cells in service)</td>
<td>1.0</td>
<td>6.3</td>
</tr>
<tr>
<td>Water backwash rate (gpm/ft³)</td>
<td>8</td>
<td>10</td>
</tr>
<tr>
<td>Air scour rate (standard cubic feet per minute (standard cubic feet of air per min per square feet (scfm/ft²))</td>
<td>3</td>
<td>4</td>
</tr>
</tbody>
</table>

C. General Design Requirements:

1. Design filter to ensure long-term stability in its operating characteristics.

2. Filter system shall be resistant to changes in head loss, flow uniformity, corrosion, and any other effects, which could affect operation.

D. Performance Requirements:
1. Filter underdrain system shall produce uniform air and water flows throughout the filter cell over the full range of normal backwash flow rates.

2. Distribution criteria:
   a. Plus or minus 10 percent of average scfm/ft\(^2\) of filter area
   b. Plus or minus 5 percent of average gpm/ft\(^2\) of filter area.

3. Perform visual tests to demonstrate compliance with the distribution criteria. Do not disturb any media during the visual test.

E. Underdrain Structural Design Requirements:

1. Net internal loading during backwash: 600 pounds per square foot (psf). No credit shall be taken for the weight of filter media in the design calculations.


3. Concrete Design: minimum compressive strength of 4,000 pounds per square inch (psi).

4. Adequate safety factors in the design shall account for dynamic loadings which may occur during the initiation and termination of air backwash.

5. Provide for all loads incurred during shipment, handling, and installation.

F. Other Requirements:

1. Furnish installation details and recommendations are necessary to acceptably interface the filter underdrain system with all surrounding structures, including requirements for leveling, grouting keys and pockets, dowels, support ledges and piers, and anchorage.

2.04 FILTRATION COMPONENTS

A. Center Core Siphon

1. Circular stainless steel cylinder with four compartmentalized siphons mounted integrally.

2. Center core shall be freestanding and attached to the concrete floor via anchor bolts at the base.

3. Design backwash siphons to initiate and maintain the flow of backwash water when vacuum is applied to each compartment.

B. Annular Flume and Inlet Siphons

1. Annular flume designed to receive the flow of inlet water and discharge it equally through inlet siphons to each filter cell.

2. Type 304 stainless steel (SS).

C. Backwash Drain

1. Provide a backwash drain for the control center to receive the flow of backwash water from the backwash siphons and discharge the backwash water from the backwash section.

2. Fabricated from a 24-inch-diameter pipe, 3/16-inch-thick minimum sidewall, and fitted with truncated conical weir at its top and a steel bolting flange at its bottom, drilled to 125-lb cast iron flange.

3. Fit all bolted joints between dissimilar metals with rubber gaskets and nylon or polyvinyl chloride (PVC) washers to prevent contact between the metals.
D. Effluent Weir
1. Rated for 500 gpm per foot of weir length at 6 inches of head.
2. Three-inch channel fabricated of 304 SS sections.
3. Channels shall be placed one above the other in the effluent chamber.
4. Provide guide angles to maintain the channels in position. Include lifting lugs welded to the back of each channel to permit easy removal for adjustment of weir height.
5. Gasket contact surfaces with ¼-inch-thick, closed cellular rubber strips cemented to the metal.

E. Vacuum Tank and Pumps
1. Provide a dual-vacuum-pump-assembly (per unit) consisting of two motor-driven vacuum pumps of adequate size to initiate and maintain design negative pressure in the high vacuum chamber of control center vacuum tank.
2. Vacuum pumps shall be rotary vane type, of cast iron construction. Pumps shall be close-coupled to the drive motor with the rotor carried on the extended motor shaft.
3. Included for the manifold assembly shall be check valves on the suction side from the vacuum tank.
4. Provide interconnecting piping between the pumps and the vacuum tank.
5. Each pump motor shall be 5.5 horsepower (hp), premium efficiency, totally enclosed and fan cooled (TEFC), suitable for 460 - volts, 3-phase, 60-hertz electrical supply.
6. Located on operating platform.
7. Painted steel vacuum tank with a compartmentalized vessel with high and low vacuum chambers for actuating the backwash and inlet siphons.
8. Provide interconnecting 304 SS piping and tubing from the vacuum tank to the backwash and inlet siphon valves, together with the necessary solenoid pilot valves.
9. Vacuum tank probe:
   a. Electrode probe to detect high and low vacuum conditions.
   b. “Magnetrol” Kotron Series 80 Electronic level control, or equal.
10. Provide check valves, control valves, strainers, and normally closed solenoid valve for the water seal line on the vacuum pumps.

F. Filter Media
1. Comply with AWWA B100-01.
2. Media Characteristics:
   a. Type: Filter Sand
   b. Depth: 4-feet
   c. Effective Size: 0.9-1.0 millimeter (mm)
   d. Uniformity Coefficient: 1.6 (maximum)

G. Wash Troughs
1. Provide one main collector (concrete construction) and two cross collector wash water troughs per cell constructed of fiberglass-reinforced plastic (FRP).

2. Troughs shall be 3/16-inch thick, reinforced as required with longitudinal stiffener sections which are not welded or bolted to the troughs, but which are molded as an integral part of the trough.

3. Provide lateral stiffness and rigidity through the use of plastic spreaders placed at strategic points along the trough and fastened with stainless steel hardware.

4. Provide an integrally molded water stop on the discharge end of each cross collector trough.

5. Integrally close the back end of all the troughs at least 1 1/2 times the thickness of the trough, and arrange for bolting to the basin wall.

6. Maintain edges of the troughs level and straight without more than 1/8-inch variation from level throughout the entire length.

7. Provide smooth, resin-rich inner surface.

8. Provide reasonably smooth outer surface, with no glass fibers exposed.

9. No voids, dry spots, cracks, or crazes.

H. Filter Valves

1. Filter Cell Isolation Valves: Provide a manual, hand-wheel operated 18-inch American Water Works Association (AWWA C504), butterfly valve with extension for each filter cell for isolation.

2. Air Scour: Provide a 6-inch diameter rubber-seated, AWWA, butterfly valve for the air piping to each filter cell. Include an open/close, electric type operator and manual override.

3. Drain Valves: Provide a manual 6-inch diameter rubber-seated, AWWA, butterfly valve for the draining of each filter cell. Include a 2-inch-nut operator with tee wrench.

2.05 UNDERDRAIN SYSTEM

A. Grout: Mixture of one part of Portland cement and two parts of sand, with non-shrink admixture.

B. Concrete: Conform with applicable specification sections of Division 3. Do not use coarse aggregate larger than ½-inch maximum diameter.

C. Metals: As specified in Division 5. Provide 304 stainless steel for all exposed (not embedded in concrete) or partially exposed metals, including but not limited to anchor bolts and anchorage, fasteners, washers, etc.

D. Plastics: High-strength, completely inert, resistant to erosion, corrosion, and degradation from chlorine up to 150 mg/L, and suitable for use with backwash temperatures from 40 to 200°F.

E. Support System:

1. Provide reinforced concrete false floor cast in place over plastic false floor forms.

2. The forms remain in place as the underside of the floor slab and provide preformed holes for locating and supporting the cast-in-place flow element inserts.
3. Install the false floor forms onto 6-inch PVC pipe columns, cut to length by the manufacturer. Install Forms onto a support angle along the perimeter walls of the filter.

4. Do not provide support columns requiring notching or other special forming. Provide systems requiring dwarf walls for support of the slab as per the underdrain manufacturer.

5. Level the ledges and columns to within plus or minus 1/8-inch before installing the false floor forms.

6. Provide for both longitudinal and transverse flow under the false floor to ensure uniformity of flow distribution.

7. Tie the false floor to the base concrete floor with adhesive anchors consisting of 5/8 inches A-36 304 SS all-threaded rods with chisel points, 3-feet by 3-feet 304 stainless steel shear plate and adhesive capsules, provided by the underdrain manufacturer.

8. Tie the false floor into the filter wall with one course of No. 4 reinforcing rods dowelled into the walls on 6-inch and 10-inch-centers.

9. Designs that require bending of cast-in dowels or rebar in the underdrain slab, support columns and/or in the filter floor slab will not be allowed. Place all wall and floor dowels accurately.

F. Plastic False Floor Forms:
1. Construct of one-piece, molded high impact NSF-61 certified polystyrene.
2. Approximate plan dimensions of 24-inch by 30-inch.
3. Provide preformed cylinders, on 6-inch and 5-inch centers, and not less than 4.8 cylinders per square foot, for receiving filter nozzles and inserts.
4. Permanent part of the finished false floor.
5. Carry stresses due to the placement of concrete with minimal deflection under the load imposed by the concrete.
6. Provide filler forms to close the area along the perimeter walls where a full form cannot fit. Cut to the appropriate size on-site to ensure accuracy.

G. Flow Nozzles and Inserts:
1. Provide a NSF-61 certified polypropylene nozzle insert into the plastic forms.
2. Snap-lock into place at each nozzle location without the need for adhesives.
3. Include a threaded, disposable seal to prevent concrete from passing through or fouling the threaded portion of nozzle.
4. Include an integral air wash tailpipe.
5. Screw nozzles into the nozzle insert adapters and provide narrow, vertical slot openings suitably sized for compatibility with the filter media. Design the slots to prevent clogging from small particles.
6. Design the nozzles to uniformly distribute washwater and air during the backwash cycle, and collect filtered water during the filtration cycle.
7. Include a 1-inch National Coarse (NC) pipe thread on each nozzle for a basket and tailpiece.
8. Design each nozzle to be totally enclosed and to withstand the same loadings as the monolithic pour.
9. Provide a tailpiece of proper design to provide for the uniform distribution of backwash water. Provide a hole in the tailpiece so placed to bleed off trapped air in the plenum.

10. Screw each nozzle into the topside of the underdrain.

11. Supply torque requirements and other installation instructions and requirements to ensure proper installation of the nozzles.

12. Supply 50 extra nozzles.

2.06 INSTRUMENTATION AND CONTROLS

A. Filter Master Control Panel (MCP) and Local Control Station (LCS)

1. Provide a Filter MCP and LCS As shown on drawings.

2. Refer to Section 16910 for Control Panel specification requirements.

3. Filter MCP
   a. The MCP shall consist of main circuit breaker, a PLC, pilot light, selector switches, pushbutton, terminal blocks, fuse and filter vacuum pumps starters.
   b. The Filter MCP shall be a PLC-based control panel with processor, I/O cards, communications interfaces, power supply and other components required for a complete, functioning of the filter control system. The PLC shall be a Micro PLC type. Refer to Section 16942 for PLC specifications.
   c. Door mounted lights, switches, and pushbutton.
   d. The following monitoring and control shall be performed at the PLC.
      (1) Vacuum pump and instrumentation status.
      (2) Filter backwash control.
      (3) When preset value is reached, initiate extraction sequence.
      (4) Open one draw-off valve at a time with slight delay in valve openings.
      (5) Terminate the sludge extraction at completion of timer-controlled sequence.
   e. Operation, monitoring and parameter configuration of the Filter PLC shall be performed from the main plant PLC through the plant operator interface terminal (OIT) and the existing DCS.
   f. Provide PLC inputs and outputs sufficient to interface with all panel and field mounted devices.
   g. The Filter manufacturer shall assist in the coordination and field testing of the data link between the MCP and the plant PLC.
   h. All PLC source code and configuration files shall be provided to the County prior to start-up. Provide one copy of the PLC programming software licensed to the County.
   i. The Filter MCP shall communicate to the Main Plant PLC via Ethernet Network Ca5 Shielded Cable.
   j. Provide the MCP in a National Electrical Manufacturers Association (NEMA) 12 enclosure.
4. Filter LCS
   a. Provide a LCS at the filter pumps for local operation.
   b. Provide a NEMA 4X FRP enclosure
   c. The following operation shall be perform locally at the Vacuum room:
      (1) Control power switch with light.
      (2) Filter operation mode switch.
      (3) Filter cell switches with service and backwash lights.
      (4) Filter cell level switches with high-level alarm lights.
      (5) Backwash step lights and advance push-button.
      (6) Vacuum pump level controls, switches, and lights.
      (7) Wiring to field devices terminated at terminal blocks.
      (8) Air blower switch and lights.
   d. Design panel for front access only with provisions to lock door.
   e. Control panel shall be fully assembled, wire, and test in the factory prior to shipment.
   f. The Control panel design, construction, and testing shall be completed in an International Organization for Standardization (ISO) 9001 certified shop by the filter manufacturer.
   g. Provide wire tags on every conductor. Provide slip-on or heat shrink sleeve markers. Tags using adhesives are unacceptable.
   h. Replace the existing Filter system control panel for a Master Control Panel and a Local Control station similar to the ones specified above.

B. Level Probe
   1. Provide an ultrasonic level transmitter; Hach or equal.

C. Backwash Operation:
   1. Do not backwash more than one filter at a time.
   2. Initiate backwash by high level, high turbidity, by timer, or manually.
   3. If high head loss occurs in a cell while another cell is in automatic backwash, remove the cell with high head loss from service and automatically backwash, once available.

D. Power Failure
   1. If a filter cell is in service, continue the service.
   2. If a cell is being backwashed, stop the backwash cycle and return the cell to service. When power is restored, start the backwash cycle from the beginning to insure that a complete cycle is performed.

2.07 WALKWAYS AND PLATFORMS
A. Provide in accordance with specification Section 05500.
B. Operating Platform Assembly
   1. Locate operating platform immediately above the annular flume and inlet siphons.

3. Handrails: 1-1/2-inch-diameter aluminum pipe with kickplates, provided for both the inner and outer courses. Comply with details on the Drawings.

C. Walkway

1. Provide a fabricated aluminum access walkway, 3-feet-wide, providing access from the edge of the filter tank to the operating platform.

2. Locate walkway above and supported from the influent flume.

3. Channel stringers braced crosswise with channels and covered with 3/16-thick standard aluminum checkered plates attached by flat head, countersunk bolts.

4. Handrails: 1-1/2-inch-diameter aluminum pipe with kickplates, provided for both the inner and outer courses. Comply with details on the Drawings.

2.08 PAINTING

A. Paint all ferrous steel shipped as bare steel in accordance with Section 09900.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install all materials and equipment as per manufacturer’s instructions.

B. Install anchor bolts and other parts in concrete in accordance with Division 3 Concrete.

C. Remove all foreign matter from the filter system prior to startup and field testing.

D. Placement and Cleaning:

1. Install as per manufacturer’s recommendations to insure that the filter, underdrain and piping is completely clean and free of any debris, dirt, or other foreign materials which could clog the filter and underdrain system or interfere with flow.

2. Before pouring of the underdrain concrete and installation of the filter media, vacuum clean the underdrain area, all cell effluent and backwash supply piping, and all surfaces that come into contact with backwash supply water.

3. As installation progresses, protect partially completed underdrain sections, with heavy building paper, masking tape, or other acceptable means to maintain cleanliness and protect the underdrain from exposure to weather and UV.

4. Remove the paper before placing the filter media.

5. Maintain cleanliness through final placement of filter media.

E. Underdrain Installation:

1. Prepare the filter floor slab and in setting the anchors to assure proper alignment and elevation with care.

2. Provide steel anchor rods as furnished by the manufacturer and set in the floor slab on both sides of the distribution flume in accordance with the Contract Drawings.

3. Screed the floor slab into a flat level plane and be free of protrusions and depressions.

4. Set the filter blocks in relatively level rows on a bed of grout over the filter floor slab. Provide plates for closing the ends of each row of blocks as furnished by the filter Manufacturer and installed at the plant.
5. After setting, aligning and joining the blocks, fill all spaces between the rows of blocks and walls with grout so that the entire bed is totally sealed and held firmly in place. Prevent any grout from entering the lateral channels, orifices or from being deposited in any manner that would interfere with flow.

6. Following the installation, clean and wash the system free of all loose materials and debris. Allow the underdrain to set for three days before applying internal water pressure. Check the system by following the backwash procedures. Observe uniformity of distribution, and factors such as structural stability of the installation.

3.02 DISINFECTION
A. Disinfect filters and appurtenances in accordance with Section 02676.

3.03 MANUFACTURER’S FIELD SERVICES
A. Provide in accordance with the Section SP-18.
   1. Manufacturer’s services provided by factory trained Engineer shall include inspect, start-up and training.
B. Provide manufacturer’s field services for ten (10) days in no more than three (3) trips to the job site.

END OF SECTION
PART 1 GENERAL

1.01 DESCRIPTION
A. Provide cascade aeration system as specified and as shown on the Contract Documents.

1.02 QUALITY ASSURANCE
A. Comply with provisions of Section GP-06 and 15050.
B. Provide a list from the equipment manufacturer of ten installations of similar type and size.
C. Aeration system manufacturer shall be responsible for providing all equipment necessary for proper functioning of the system.
D. Aeration system manufacturer shall be responsible for ensuring Contractor correctly installs systems as specified.
E. Manufacturer shall be responsible to provide the necessary service engineers to repair and/or replace any defective components during the warranty period including any and all travel expenses incurred for same.

1.03 SUBMITTALS
A. Comply with Section SP-09. Include the following information:
   B. Submit Shop Drawings and Product Data for cascade aerators to include:
      1. Dimensions, construction and installation details, materials used, and shipping and operating weights of the equipment.
      2. Manufacturer's literature and catalog cuts of purchased items.
      3. Design calculations for the aerator design.
   C. Submit Operation and Maintenance Manuals in accordance with Section SP-10 and to include:
      1. Complete manufacturer's installation instructions with detailed installation drawings.
      2. Complete manufacturer's maintenance instructions with complete catalog information, parts list, and instructions for periodic maintenance of the aeration unit.
   D. Submit certificate from manufacturer as specified in Section SP-08.

1.04 PRODUCT DELIVERY, STORAGE, AND HANDLING
A. Deliver, handle, and store the equipment in accordance with Section SP-14.
B. Store fabricated parts delivered to the site off the ground and protected from weather and damage.
C. Make supplier ship fabricated assemblies in largest sections permitted by carrier regulations and match-mark all sections for ease of field installation.
D. Prevent damage to equipment during handling and transportation.
PART 2 PRODUCTS

2.01 MANUFACTURERS
A. Siemens Water Technologies.
B. Tonka Equipment Company.
C. Or equal.

2.02 SERVICE AND DESIGN CONDITIONS
A. Provide two aluminum cascade aerators with associated equipment to comprise a complete system.
B. Design the unit to oxidize dissolved iron and effect reduction of dissolved gases such as carbon dioxide, hydrogen sulfide, radon from the raw water.
C. General Design Criteria:
   1. Material of construction: Aluminum
   2. Capacity of aerator (gpm): 3,000
   3. Diameter (feet): 8
   4. Height (feet): 8
   5. Influent connection (inch): 20
   6. Effluent connection (inch): 20
   7. Collector box diameter (feet): 10
   8. Collector box depth (feet): 1

2.03 AERATOR
A. Provide two aluminum cascade aerators of minimum seven-pass cascade design.
B. Each shop assembled aerator shall consist of three 8-feet diameter, ¼-inch thick, #3003F or #3003-H-14 or #5052 aluminum catch bowls fitted with perimeter splash guards and mounted on and supported by a 20-inch aluminum central inlet pipe.
C. Mounted below each catch bowl shall be an aluminum deflector plate. All mounting plates and braces shall be designed to prevent undue vibration when aerator is in operation.
D. Provide properly located spray baffles to effectively eliminate over spray without interfering with free passage of air throughout the splash areas.
E. The aluminum central inlet pipe shall have an overflow baffle at top and a bottom-mounting flange.

2.04 FINISH
A. Surfaces in contact with concrete or other dissimilar metal shall be shipped as bare metal for field placement onto a mastic base pad coating.
B. Provide equipment free from oil, grease, protective mill coatings, and other soluble contaminants.

PART 3 EXECUTION

Project No: W804000 11030-2 9/8/2010
Project Name: Broad Creek II Water Treatment Plant
3.01 INSTALLATION
   A. Install in accordance with the instructions of the manufacturer and in accordance with the Contract Documents.

3.02 FIELD QUALITY CONTROL AND TESTING
   A. Perform field inspection and testing in accordance with Section 01650.

3.03 MANUFACTURER’S FIELD SERVICES
   A. Provide manufacturer’s field services in accordance with Section SP-18.
   B. Have manufacturer's representative check and verify installation of equipment is in accordance with Drawings and manufacturer’s installation instructions prior to starting equipment and provide installation certificate.
   C. Provide a qualified factory-trained field technician to check equipment, start up and instruction of operating personnel, with a one eight-hour-day at the jobsite.

END OF SECTION
SECTION 11120
CLEARWELL PUMPS

PART 1 GENERAL

1.01 DESCRIPTION
A. Provide vertical turbine open lineshaft pumps including bowl assembly, suction strainer, column and open line shaft, discharge head, sole plate, sealing assembly and driver as per Contract Documents.

1.02 QUALITY ASSURANCE
A. Comply with Section General Provisions.
B. Provide standard components of a manufacturer who has built vertical turbine pumps of an equal or larger capacity for at least five years.
C. Provide vertical turbine pumps and appurtenances from a single manufacturer. The manufacturer shall be responsible for the following for the pumping systems.
   1. Design.
   2. Coordination.
   3. Proper operation of the Pumps and Motors.
D. Comply with applicable standards including, but not limited to the most recent edition of the following:
   1. Hydraulic Institute (HI).
   4. Anti-friction Bearing Manufacturers Association (AFBMA).
E. Design to provide satisfactory performance under the specified operating conditions.
F. Provide components that are the standard product of a manufacturer regularly engaged in the production of the required materials and equipment.
G. Assemble and test all components before shipment.
H. Design for continuous duty operation.

1.03 SUBMITTALS
A. Comply with Section SP-09.
B. Submit Shop Drawings and Product Data for all system components demonstrating compliance with Specifications, including:
   1. Make, model, and weight of each equipment assembly.
   2. Manufacturer’s catalog information, descriptive literature, specifications, and a complete bill of materials including identification of materials of construction.
   3. Certified structural, mechanical, electrical, and erection drawings showing important details of construction, equipment dimensions, size, anchor bolt locations, and locations of connections to other work.
4. Certified pump performance curves showing flow, head, efficiency and BHP over the manufacturer’s recommended operating range.
   a. Indicate limits of stable operation where pumps will operate without cavitation, surging or excessive vibration.
5. Lubrication requirements.
6. Certified NPSH curve based on previous shop test data from similar pumps or actual test data of project pumps.
7. Motor data. Identify
   a. Nominal rated horsepower.
   b. Rated ambient temperature.
   c. Service factor.
   d. Power requirements.
   e. Required full load current at rated horsepower.
   f. Starting code letter.
   g. Locked rotor KVA and current.
8. Impact test results on each pump motor to establish its actual Reed critical frequency value.
9. Special shipping, storage and protection, and handling instructions.
10. A list of manufacturer’s recommended parts required to maintain the equipment for a period of one year, with current price information.
11. A list of special tools, materials, and supplies furnished with the equipment for use prior to and during startup, and for future maintenance.
12. Manufacturer’s installation instructions.
C. Submit manufacturers’ certificates in accordance with Section SP-08.
D. Submit Operation and Maintenance Manuals in accordance with Section SP-10.
E. Submit list of required spare parts for the system.

1.04 PRODUCT DELIVERY, STORAGE, AND HANDLING
A. Deliver, handle, and store the equipment in accordance with Section SP-14.
B. Comply with American National Standards Institute/Hydraulic Institute (ANSI/HI) 2.4
   1. Covered, dry and ventilated storage may be used if stored on site for less than 60 calendar days.
   2. Storage on site for longer than 60 days shall require the manufacturer to prepare the equipment for long term storage prior to shipment.
      a. Rotate pump and driver shaft for the duration of long term storage.
      b. Frequency of rotation shall be as recommended by the manufacturer.
      c. Maintain log indicating time of rotation. Log shall be initialed by the Engineer.

1.05 SPECIAL TOOLS AND SPARE PARTS
A. Provide spare parts recommended by the manufacturer and including but not limited to the following:
1. One gauge of each type
2. One complete set of pump bearings for each pump
3. One pump shaft sleeve for each pump
4. One complete set of seal packing
5. One inlet screen for each type

B. Furnish one complete set of all special tools required to disassemble, service, repair, and adjust the equipment. Include:
   1. Tools that are unique to the equipment provided.
   2. Tools that are not readily available from an industrial tool supplier such as “Snap-On” or Mac Tools.

PART 2 PRODUCTS

2.01 MANUFACTURERS
A. Flowserve
B. Goulds Pumps
C. or Equal

2.02 SERVICE AND DESIGN CONDITIONS

A. General
1. Provide three pumps with sole plates in the clearwell of the filter Building as per Contract Drawings.
2. Design conditions:
   a. Flow: 1,750 gallons per minute (gpm)
   b. Total dynamic head: 44 feet
   c. Maximum pump speed: 1,770 rotations per minute (rpm)
   d. Minimum pump bowl efficiency: 76 percent
   e. Maximum shutoff Head: 71 feet
   f. Minimum submergence: 2 feet
   g. Motor size: 30 horsepower (hp)
   h. Liquid pumped: Filtered water

B. Design
1. Rotation
   a. Counterclockwise rotation when viewed from the driver end looking at the pump.
2. Impeller:
   b. One-piece construction, single suction, enclosed radial flow design.
   c. Extremely smooth contours, devoid of sharp corners, through waterways so as to promote maximum efficiency.
d. Dynamically balanced and secured to the shaft with tapered lock steel collets.

e. Adjustable vertically by external means at the driver location.

3. Bowls:
   a. Close-grained cast iron conforming to ASTM A48 CL30.
   b. Castings shall be free from blowholes, sand holes and shall be accurately machined and fitted with register fit circles.
   c. Flange connected.
   d. Designed with smooth passages to ensure efficient operation and their interior shall be porcelain lined.
   e. Porcelain lined

4. Impeller Shaft
   a. 1.69-inch-diameter 416 stainless steel (SS) construction conforming to ASTM A582.
   b. Supported by bronze bearings located on both sides of each impeller.
   c. Stainless steel coupling.

5. Column pipe
   a. Total length of discharge column shall be as provided by the manufacturer in accordance with the Contract Drawings.
   b. Minimum 10-inches inside diameter.
   c. Flanged and furnished in interchangeable sections not over 5-feet-long.

6. Line shafts
   a. Amply sized to transmit the torque and operate the pump without distortion or vibration.
   b. 1-inch-diameter and made of 416 SS conforming to A582 Type 416 and be furnished in interchangeable sections not over 10-feet-long.
   c. Stainless steel couplings.
   d. Stainless steel replaceable sleeves at each bearing, American Iron and Steel Institute (AISI) 304 material.
   e. Bearings of Buna–S rubber material.
   f. A48-CL30 cast iron retainers.

7. Discharge Head Assembly
   a. Made of ASTM A48 Class 30 cast iron, free of blow holes, sand holes and other detrimental defects and shall be accurately machined.
   b. Include elbow with a standard 10-inch-125-pound ANSI pipe flange integrally cast.
   c. Shaft sealing assembly
      (1) Cast iron packing box
      (2) Bronze packing gland
      (3) Pressure reducer bushing
(4) SS packing gland nuts and bolts  
(5) Synthetic packing and a Teflon water seal  
d. Packing box rated for 100 pounds per square inch (psi).  
e. Driver mounting-base shall be fitted with guards to prevent access to the  
   rotating shaft and/or coupling.  

8. Motor  
a. Confirm to Division 16  
b. Vertical hollow shaft National Electrical Manufacturers Association  
   (NEMA)-weather-protected-type with non-reverse ratchet.  
c. Nominal rating not to exceed 30 hp.  
d. Vertical motor suitable for carrying all thrust loads over the entire pump  
   performance curve.  
e. Motor shall be equipped with a non-reverse ratchet assembly and  
   provided in a weather protected, type one enclosure.  
f. Provide premium efficiency type motor.  
g. 460-volt, 3-phase, 60-hertz, power supply.  
h. Squirrel cage, induction type and shall not be overloaded beyond the  
   nameplate rating at any point on the pump performance curve.  
i. Thrust bearing  
(1) Capable of carrying all thrust generated by the pump from zero  
    head to shutoff of the rotating parts, plus the hydraulic thrust of  
    the pump impellers.  
(2) Include safety factor based on an average life expectancy of at  
    least five years of operation at 24-hours-per-day under normal  
    conditions.  
(3) Bearing shall be capable of withstanding a momentary upthrust  
    of at least 30 percent of the rated downthrust capacity of the  
    bearing.  

2.03 SHOP PAINTING  
A. Clean and shop prime the following surfaces.  
   1. Exterior of bowl assembly.  
   2. Interior of suction bell.  
   3. Exterior of column and discharge head.  
B. Surface preparation shall comply with Section 09900.  
C. Select the primer to be compatible with the specified finish coat.  

PART 3 EXECUTION  
3.01 SHOP TESTING  
A. Test each pump and driver in a test facility that has been approved by the Engineer.  
   Perform the following in accordance with the latest edition of ANSI/HI 2.6:  
   1. Hydrostatic Test  
      a. Maintain hydrostatic test pressure for 5 minutes.
b. Test all liquid containing components.

2. Performance Test
   a. Conduct test on fully assembled pump and motor.
   b. Evaluate mechanical operation of each pump and motor.
      (1) Overheating
      (2) Cavitation
      (3) Excessive Vibration
      (4) Leakage
   c. May be witnessed by the Owner.
      (1) Provide Owner with 10 calendar days written notice.
      (2) Owner will pay their own expenses to observe testing.
   d. Demonstrate compliance with the specified performance.
   e. Provide certified performance curve.

B. Conduct each test in accordance with Hydraulic Institute Standards.

C. Submit all test results to the Engineer. Test results must be approved by Engineer prior to shipping a pump and driver to the project site.

3.02 INSTALLATION
   A. Install all pumps and appurtenances in accordance with the manufacturer instructions, ANSI/HI 2.4, and the Contract Documents.
   B. The manufacturer shall supervise installation of all pumps and appurtenances.

3.03 FIELD PAINTING
   A. Field-prepare and paint all shop primed pump surfaces as specified in Section 09900.

3.04 FIELD QUALITY CONTROL AND TESTING
   A. Perform field inspection and testing in accordance with Section 01650.
   B. Demonstrate compliance with all requirements of these specifications.

3.05 MANUFACTURER’S FIELD SERVICES
   A. Provide manufacturer’s field services in accordance with Section SP-18 and the following:
      1. Supervise the installation.
      2. Inspect equipment after installation.
         a. Provide engineer with a written inspection report.
         b. Issue manufacturer’s certificate of proper installation in accordance with Section SP-08 when equipment is ready to operate as designed.
   B. Training
      1. Provide two trips of 8 hours each to instruct representatives of the Owner and Engineer.

END OF SECTION
PART 1 GENERAL
1.01 DESCRIPTION
A. Provide new lime feed system and retrofit the existing lime silos as shown on the Contract Documents.
B. Modification to the lime feed system will generally include, but is not necessarily limited to, the following:
   1. Modification to the existing lime silos.
   2. New bin activators
   3. New screw conveyors
   4. New weigh batch tanks
   5. New transfer pumps
   6. New day tank and load cell
   7. New slurry metering pumps
   8. New utility water system
   9. Instrumentation and controls
   10. Accessories as specified

1.02 QUALITY ASSURANCE
A. Comply with applicable portions of General Provisions and Section 15050.
B. Provide components that are the standard product of a manufacturer regularly engaged in the production of the required materials and equipment. Manufacturer or supplier shall have at least five successful operating systems producing and pumping 35-percent by weight, calcium hydroxide slurry. Operating systems shall have been in operation for more than three years. Plant addresses, contact persons, and phone numbers shall be provided upon request.
   1. A single manufacturer or supplier shall provide the complete lime storage and feed system including appurtenances.
   2. The manufacturer or supplier shall be responsible for the design, construction, control and proper operation of all components.
C. Comply with applicable standards including, but not limited to the most recent edition of the following:
   1. American Society of Testing and Materials (ASTM)
   2. National Electrical Manufacturers Association (NEMA)
   3. American Welding Society (AWS)
   4. Steel Structures Painting Council (SSPC)
D. Provide satisfactory performance under the specified operating conditions.
E. Field-locate and mount the components, pipe and install in accordance with the manufacturers recommendation.
F. System supplier shall be responsible for the system performing its intended functions and operating in a satisfactory manner. Specifically, the system shall continuously deliver high-density lime slurry at the required rate to the feed points.

1.03 SUBMITTALS

A. Comply with Section SP-09. Include the following information:

1. Make, model, and weight of each equipment component including appurtenances.

2. Manufacturer’s catalog information that describes each item provided. Include:
   a. Complete specifications
   b. A complete bill of materials that identifies all materials of construction.
   c. Description of operation
   d. Control schematics and wiring diagrams.

3. Certified structural, mechanical, electrical, and erection drawings. Show:
   a. Important construction details,
   b. Fabrication drawings,
   c. Equipment dimensions,
   d. Electrical interconnection diagram
   e. Size and location of anchor bolts, and
   f. Locations of connections to other work.

4. Special shipping, storage, protection, and handling instructions.

5. Control Panel
   a. Shop Drawings:
      (1) Instrumentation and control system schematics, tubing and conduit details, and wiring diagrams for electrical and control components furnished.
      (2) Any necessary dimensioned drawings to coordinate piping layout with structural, architectural, electrical and/or other mechanical work.
      (3) Cut sheet of all equipment and devices provided as part of the system.
   b. Process Control and Instrumentation:
      (1) Complete system block diagram with all inter-equipment wiring and conduit requirements.
      (2) Point-to-point interconnection wiring diagrams, indicating field instrumentation and control panel connections.
      (3) Panel wiring, conduit diagrams, and input/output (I/O) modules layout.
      (4) English-language loop descriptions.
      (5) Instrument index with ranges and set points.
      (6) Fully documented ladder logic programmable logic controller (PLC) program listing including the I/O list and housing
configuration for each PLC. Provide an electronic file of documented PLC programs.

(7) Copies of all proposed database and data to be transferred to Plant PLC and existing digital control system (DCS) system.

(8) Detailed factory testing procedure.

(9) Detailed electrical schematics and layout drawings including interior panel layout, detailed interface and interconnection drawings indicating interlock signals, terminal connections, field instrumentation, electrical device sizing such as fuses, circuit breakers, etc.

6. Detailed description of operation.

7. List of manufacturer’s recommended parts required to maintain the equipment for a period of one year, with current price information.

8. List of special tools, materials, and supplies furnished with the equipment for use prior to and during startup, and for future maintenance.

9. Any additional information to demonstrate compliance with these specifications.

B. Submit Operation and Maintenance Manuals in accordance with Section SP-10. Include:

1. A list of manufacturer’s recommended parts required to maintain each equipment item for a period of one year, with current price information.

2. A list of special tools, materials, and supplies furnished with each equipment item for use prior to and during startup, and for future maintenance.

3. Manufacturer’s installation instructions.

C. Submit manufacturer’s certificates in accordance with the Section SP-08.

1.04 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Deliver, handle, and store the equipment in accordance with Section SP-14.

B. Implement manufacturer’s long-term storage and handling procedures if equipment will be stored longer than 2 months before it is installed and placed into operation.

1.05 SPECIAL TOOLS AND SPARE PARTS

A. Provide spare parts recommended by the manufacturer. At a minimum, provide the following spare parts in total:

1. One pump for each type
2. Pump hose
3. One gallon of pump lubricant

B. Furnish one complete set of special tools required to disassemble, service, repair, and adjust the equipment.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. System Supplier

1. Merrick Industries, Inc.
2. Or equal
2.02 SERVICE AND DESIGN CONDITIONS

A. Design Criteria

1. Lime (calcium hydroxide) 37.5 percent
2. Maximum dry density: 35 pounds per cubic feet (lbs/cu ft)
3. Maximum batch rate per system: 100 gallons per hour (gph)
4. Transfer pump rate from batch tanks to day tank: 720 gph
5. Volume of each batch tank: 300 gallons
6. Volume of day tank: 300 gallons
7. Maximum feed rate of metering pumps: 60 gph

B. Installation

1. Use minimum 1/4-inch thick plates and structural steel members conforming to ASTM A36 unless otherwise specified.
2. Perform shop welding using shielded arc technology and conform to the latest standards of the AWS.
3. Support chutes, isolation valves or similar devices from the building floor.

2.03 BIN ACTIVATORS

A. Bin Activators

1. Provide two new bin activators, one on each existing lime silo.
2. Provide 6-feet-diameter activators.
3. Designed to assure uniform density and flow.

B. Motors

1. Totally enclosed fan cooled (TEFC), 3 horsepower (hp), premium efficiency, motor
2. 460-volt, 3-phase, 60-hertz power.

C. Accessories

1. Forged vibration isolator hangers
2. Integral baffle
3. Mounting support ring
4. Hanger brackets
5. Nordel beaded flexible sleeve with clamp retainer,
6. 304 stainless steel (SS) clamps,
7. 3/16-inch wire clamping beads for the bin activator and mounting ring.
8. 10-inch diameter flanged outlet and handwheel-operated 10-inch knife gate valve.
D. Installation
1. Weld the manufacturer-provided support rings to the existing silos before cutting the cone. 
2. Raise the bin activator into place, and secure with the supplied hangers and fasteners and wire to the control panel per manufacturers’ instructions.

2.04 FEED CONVEYER
A. Screw Conveyors
1. Two 3-inch inclined screw conveyors.
2. Each conveyor shall transfer 33-50 cu ft./hr. hydrated lime at dry density of 30 lbs./cu ft.
3. Construct rigid carbon steel tube, stainless steel fasteners, a stainless steel helix and spout.
4. Above the make-down tank inlet. Connect to tank using a dust-tight drop pipe and flexible discharge spout.
5. Terminate each conveyor.

B. Motor
1. 2-hp, TEFC, premium efficiency motor
2. 460-volt, 3-phase, 60-hertz power.

C. Provide 10-inch inlet to match the bin activator outlet and a 6-inch discharge with flexible connector.

D. Installation
1. Support the lower ends of the screw conveyors from the floor and the upper ends by a painted carbon steel frame from the batch tanks.

E. Controls
1. Provide the feeders with start and stop run switch.
2. Feeder automatically operates to batch the lime to the slurry make-down tank, according to level sensors and pump feed rates.

2.05 BATCH TANKS AND MIXERS
A. Tanks
1. 3-feet-wide by 3-feet-long by 5-feet-deep batch tanks.
2. A minimum of 250-gallons-storage volume, each.
3. Designed to maintain a 37.5 percent slurry concentration, regardless of withdrawal rates.
4. Fabricate the tank of reinforced heavy-gauge, epoxy-coated, carbon steel with bolted and gasketed cover, with access doors.
5. Equip the tanks with ultrasonic level monitors, vents, drain valves, breather assemblies.
B. Mixers
1. Provide heavy-duty, slow-speed gear drives.
   a. 1.5 hp, TEFC, premium efficiency motors.
   b. 460-volt, 3-phase, 60-hertz, power.
2. Mixer shafts and impellers
   a. 1.25-inch-diameter mixer shafts.
   b. Provide two axial-type, 10-inch-diameter-impellers
   c. Include stabilizer rings on the lower impellers.
3. Flange-mount the gears and motors on standard 6-inch, 150-lb. flange faces and
   the shaft and a low pressure stuffing box.
4. Install the mixer mounted on a 10-degree angle on the tank cover, prewired and
   tested in factory, as provided by the supplier.

C. Fittings and make up water manifold
1. Install the piping as per drawings to the threaded connections for
   a. 1-inch make-up water
   b. 2-inch overflow
   c. 1-inch slurry discharge
   d. 4-inch drain
2. Equip the make-up water lines with a brass solenoids including 120 volts
   alternating current (VAC) coil connection to the control panel to start and stop the
   make-up water.
3. Field-mount the water inlet manifold as provided by the manufacturer. Manifold
   shall include a shut-off valve, inlet strainer, flow meter with 4-20 milliamperes
   (mA) output and a throttling control valve for adjusting the water-to-lime slurry
   concentration.

D. Ultrasonic control
1. Install National Electrical Manufacturers Association (NEMA) 4, ultrasonic level
   controls to provide high and low level alarms, operating levels, and 4-20 mA
   output signal proportional to slurry tank levels to the system control panel.
2. Mount the meters on an integral stilling well, fabricated as part of the slurry tanks.

E. Load Cells and Scale
1. Equip the tank with four legs each mounted upon a properly sized load cell.
2. The cells shall be connected through a summing devise to a weigh scale.
3. The signal provided from the scale to the programmable logic controller (PLC)
   based control panel will control the slurry make-down process, maintaining the
   preselected lime concentration.

2.06 SLURRY TRANSFER PUMPS
A. Provide one slurry transfer pump per batch tank.
B. Provide Verderflex model VF32 close coupled gear drive, peristaltic type, heavy-duty
   hose pumps.
C. Each Pump shall pump 37.5 percent lime slurry at 12 gallons per minute (gpm) at pressure of 30 pounds per square inch (psi).

D. Pump rotor, shoes and hose operate in food-grade oil.

E. Pump housing shall include a polycarbonate inspection window to view level. An integral hose-burst-detection-monitor shall be wired to the control panel for shut-down.

F. The pump shall driven by a mechanical gear drive with a variable-speed motor at a maximum speed of 80 rotations per minute (rpm).

G. Provide pumps capable of running both forward and reverse.

H. Motors
   1. Motors shall be inverter-duty, 2-hp, TEFC, premium efficiency for 460-volt, 3-phase, 60-hertz, electrical supply.

I. Control System
   1. Mount the local controls in the main control panel and provide for run status report back, Hand-Off-Auto, and forward-reverse switching.
   2. Pump shall start and stop based on the weight transmitted to the main PLC from the from the remote slurry day tank scale. Provide automatic operation with manual override.

J. Equip the pumps with piping and pinch-type shut-off valves for independent operation and a high-pressure cut-out switch in the discharge line to provide an alarm output.

2.07 DAY TANK

A. Tank shall be located upon an electronic, low-profile tank scale platform, approximately 4.5 feet square. Scale shall be constructed of reinforced steel rated for 5000 lbs and coated with a corrosion-resistant, plasticized tuff-coat finish.

B. Day tank shall be a linear-high-density-polyethylene, heavy-wall, cylindrical, flat-bottom tank; including a reinforced, bolted and gasket cover with hinged access with a mounting pad and support for a low speed gear drive mixer.

C. Mixer
   1. 1-hp, TEFC, premium efficiency motor
   2. 1-inch, 316 SS shaft
   3. 12-inch propeller
   4. Maximum speed 350 rpm

D. Connections
   1. Transfer pump inlets
   2. Metering pump outlets
   3. Overflow
   4. Drain, and U-vent

E. Provide pipe supports and suitable flexible connections at each connection point to prevent any weight transfer to the day tank scale.

F. Controls
   1. 120 VAC scale indicator in NEMA 4X, wall-mounted enclosure.
2. 32-digit liquid crystal display (LCD) providing numerical weight in pounds and a zero to 100 percent, bar graph reference. The scale also provides a 4-20 mA analog output to the PLC, as well as four independent, adjustable, level relays for controlling tank fill and high or low alarms.

2.08 SLURRY METERING PUMPS

A. Metering Pumps

1. Provide three, skid mounted Verderflex Model Dura 15 vertical, close-coupled, gear-driven, peristaltic-type, heavy-duty hose pumps.

2. Each pump shall pump 37.5 percent lime slurry at a rate of 5 - 60 gph at pressure of 40 psi.

3. Pump rotors, shoes and hoses shall operate in food grade glycerin. Housings shall include a polycarbonate inspection window. Pumps shall have a leak detection sensor to monitor high or low fluid levels.

4. Motors

   a. Motors shall be inverter-duty, 1- hp, TEFC and premium efficiency.
   b. 460-volt, 3-phase, 60-hertz.
   c. Mechanical gear drive with a variable-speed motor. Maximum pump speed shall be 75 rpm.

5. The pumps shall be capable of running both forward and reverse.

6. Control system

   a. Local controls shall be mounted in the new control panel and provide for run status, hand-off-auto, and forward-reverse switching.
   b. The pumps start and stop from the plant run switch and shall include a variable-speed controller to allow for automatic proportional operation from a 4-20 mA analog signal.

7. The pumps shall include piping and full-bore, ball-type shut-off valves for independent operation. High pressure cut-out switches the discharge lines shall provide alarm outputs.

B. Pump discharge manifolds

1. Furnish one pre-piped and assembled slurry discharge manifold either pump may feed either or both the discharge points.

2. Manifold shall provide two discharge points and cross-connection valve assembly.

3. Manifold shall be connected to the feed points with flexible hose.

4. Manifold shall be constructed of Schedule 40, 304 stainless steel pipe and includes the following:

   a. Isolation, shut off and bypass ball valves
   b. Pulsation Dampeners
   c. Pressure switch and gauge with isolator

2.09 CONTROL PANEL

A. Electrical requirements shall be 460 VAC, 3 Phase, 60 Hz, 50 Amp.
B. The lime Control panel shall be and PLC based system. That include as a minimum the following:

1. PLC processor, I/O cards, communications interfaces, power supply and other components required for a complete, functioning of the clarifier control system. The PLC shall be a Micro PLC type. PLC shall communicate with Plant PLC and DCS system via Ethernet network fiber optic cable. Comply with Section 16942 for PLC specifications.

2. The control panel shall be prewired NEMA control panel with NEMA rated starters or variable frequency drives (VFD) for all motors. Refer to Specification Section 169157 for VFD requirements.

3. Pilot lights, selector switches, push buttons, power supplies, displays, circuit breakers, transformer, terminal blocks. Refer to Specification Section 16946 for Control Panel requirements.

4. Provide overload protection, main and branch circuit breakers and pilot devices for all equipment, including bin activators, inclined feeders, level sensors, flow meters, mixers, electric valves, transfer and metering pumps.

5. All terminals provided by the manufacturer shall be identified and tagged before shipping. The internal wiring and terminations conform to National Electrical Code (NEC) standards.

C. Install the necessary wires and conduit in accordance with NEC standards to interconnect the components to the panel.

D. All lime system devices and equipment shall be wired to/from the Lime Master Control Panel.

E. The following monitoring and control shall be performed at the PLC.

1. Monitor and control the lime system equipment: Silo levels, Bin Activators, Inclined screw conveyors, Mixers, Load cells, electric valves, metering pumps.

2. Local operation from the Local Control Panel or Remote operation from the Plant OIT or DCS.

3. Operation, monitoring and parameter configuration of the Lime PLC shall be performed from the Main Plant PLC through the Plant Operator Interface Terminals (OIT) or the existing DCS workstation Operator.

4. The Lime System manufacturer shall coordinate with the ISS and APS the data to be transferred between the MCP and the Plant PLC.

5. All PLC source code and configuration files shall be provided to the County prior to start-up. Provide one copy of the PLC programming software licensed to the County.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install the lime storage and feed system and appurtenances in accordance with the instructions of the manufacturer and these Contract Documents.

3.02 FIELD PAINTING

A. Field-prepare and paint required surfaces as specified in Section 09900.

B. Repair factory finished surfaces which have been damaged.

C. Protect metal surfaces in contact with concrete as specified in Section 09900.
3.03 FIELD QUALITY CONTROL AND TESTING
   A. Perform field inspection and testing in accordance with Section 01650.

3.04 MANUFACTURER’S FIELD SERVICES
   A. Provide manufacturer’s field services in accordance with Section SP-18.
   B. Training
      1. Provide two eight-hour-days of operating and maintenance instruction to representatives of the Owner and Engineer.

END OF SECTION
SECTION 11230
POLYMER SYSTEM

PART 1 GENERAL

1.01 DESCRIPTION
A. Provide skid mounted polymer feed units and accessories as shown on the Contract Documents.

1.02 QUALITY ASSURANCE
A. Comply with applicable portions of General Provisions and Section 15050.
B. Costs resulting from changes to structure, piping, or electrical work required for equipment from other manufacturers shall be Contractor’s responsibility.
C. Polymer system manufacturer shall be responsible for systems functioning as specified.

1.03 SUBMITTALS
A. Comply with Section SP-09.
B. Submit Shop Drawings to include the following:
   1. Catalog cut sheets
   2. General assembly drawings
   3. Functional schematic diagrams
   4. Electrical schematics
   5. Control panel layouts
C. Submit manufacturers’ certificates in accordance with Section SP-08.
D. Submit Operation and Maintenance Manuals in accordance with Section SP-10.

1.04 PRODUCT DELIVERY, STORAGE, AND HANDLING
A. Deliver, handle, and store the equipment in accordance with Section SP-14.

PART 2 PRODUCTS

2.01 MANUFACTURERS
A. Stranco of Bradley, IL.
B. ProMinent Fluid Controls, Inc.
C. Or equal.

2.02 SERVICE AND DESIGN CONDITIONS
A. Design Criteria:
   1. Polymer Feed Units: Provide following polymer feed units. All model numbers refer to Polyblend polymer feed units, as manufactured by Stranco, Inc. of Bradley, Illinois. Polymer feed units to consist of following:
      a. Polymer feed pump (diaphragm metering pump)
      b. Feed pump controller
      c. Mixing chamber with mechanical mixer
      d. Dilution water rotameter and controls.
e. Water-supply solenoid valve.
f. System controller

<table>
<thead>
<tr>
<th>Quantity</th>
<th>Chemical Pumped</th>
<th>Model No.</th>
<th>Neat Polymer Feed Capacity (gallons per hour (gph))</th>
<th>Dilution Water Capacity (gph)</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>NALCLEAR 7768</td>
<td>M601-D1AA</td>
<td>0.05-1.0</td>
<td>30-600</td>
</tr>
</tbody>
</table>

B. Accessories:
1. Provide following accessories with each feed pump head. Applicable sizes and arrangements as shown on Drawings:
   a. Flexible suction and discharge tubing with clamps
   b. Spare gaskets
2. Provide following accessories with each polymer feed system:
   a. Calibration kit (250 milliliter (ml))
3. Provide an additional pump along with manufacturer recommended spare parts.

2.03 POLYMER FEED UNIT

A. Provide polymer feed units and accessories capable of pumping indicated liquid over ranges shown.
1. Materials shall be compatible with polymer.

B. Automatic polymer dilution/feed system shall consist of an integrated equipment package capable of automatically metering, diluting, activating and feeding liquid polymer and water.
1. System shall activate concentrated polymer in a two-stage continuous process within a single vessel.
   a. First stage shall consist of a turbine mixer to impart high-energy mixing.
   b. Second stage mixing shall be provided by use of a baffle.
2. Mixer Motor: 0.5 horsepower (hp), totally enclosed and fan cooled (TEFC), continuous duty.
3. Activation chamber shall be suitable for 100-pounds per square inch (psi) working pressure.
4. Metering Pump: Diaphragm-type metering pump shall be provided with variable stroke frequency and stroke length.
   a. Metering pump shall be capable of pumping solution-type or emulsion-type polymers with apparent viscosities of up to 45,000 centipoise (cps).
   b. Metering pump shall be controlled by means of a remote control module with digital display of pump output in strokes per minute or strokes per hour.
5. Dilution Water:
   a. Provide solenoid valve for on/off control of dilution water supply and rotameter flow indicators equipped with rate-adjusting valves to control water to two separate stages of dilution.
   b. Provide static mixer for blending stock polymer and dilution water.
6. **Flow Sensor:** Provide a loss-of-flow sensor to turn off polymer feed pump, if water flow is interrupted.
   a. Automatic pump restart when water flow is restored.

7. **Metering pump construction:**
   a. Frames of 304 stainless steel with Schedule 80 polyvinyl chloride (PVC) for piping.
   b. Mixing chamber of clear acrylic with PVC end caps.
   c. Brass impeller and shaft.
   d. Double-sealed bearings.

8. **Electrical:** Provide feed pumps and mixers suitable for 120-volt, 1-phase 60-hertz power supply, controlled by a single Hand / Off / Remote switch with remote contact to digital process control system (DCS). Pacing signal to be 4-20 mA, proportional to flow.

9. **Control Panels:**
   a. Control panel for each feed unit shall be skid-mounted National Electrical Manufacturers Association (NEMA) 12 enclosure including, but not limited to, Hand-Off-Remote switch, running light, and disconnect switch.
   b. Provide each control panel with contact for use in generating a feeder running status signal.
      (1) In "Remote" position, unit shall be started and stopped from DPCS system.
   c. Provide metering pumps with remote electronic module mounted on polymer feed unit capable of accepting a 4-20 mA pacing signal for use in adjusting feed rates in proportion to flow.
      (1) Module shall include a Local/Remote switch, a digital display showing pump stroke speed, a rate-set knob to manually adjust pump stroke speed and a running light.

C. **Calibration Kit:** Provide 250 ml, clear plastic, graduated cylinder, shut-off valves, and flexible tubing.
   1. Furnish kit with all necessary hardware for mounting directly on polymer feed unit.

D. **Pressure-Reducing Valve:** Furnish with pressure reducing valve to limit water supply pressure to 25-75 psi.

E. **Frame dimensions:** 36-inches-wide by 28-inches-deep by 50-inches-high.

F. Skid constructed of 304 stainless steel (SS).

**PART 3 EXECUTION**

3.01 **INSTALLATION**
   A. Install polymer feed pumps, accessories and calibration kit in accordance with the instructions of the manufacturer and in accordance with the Contract Documents.
   B. Perform power and control wiring as work of Division 16.

3.02 **FIELD QUALITY CONTROL AND TESTING**
   A. Perform field inspection and testing in accordance with Section 01650.
B. Test feeders in presence of Engineer to determine that equipment delivers chemicals within specified accuracy over range of feeder.

1. Test a minimum of four set feed rates.
2. Test each run for at least 10 minutes.
3. Make no adjustments while test is in progress.
4. If equipment fails to meet specifications, make adjustments, modifications, or equipment changes necessary to meet specified standards.
5. Run new tests until equipment meets Specifications.

3.03 MANUFACTURER’S FIELD SERVICES

A. Provide manufacturer’s field services in accordance with Section SP-18.

B. Manufacturer’s representative shall check and verify installation of equipment is in accordance with Drawings and manufacturer’s installation instructions prior to starting equipment. Manufacturer shall provide installation certificate.

C. Provide factory trained manufacturer’s representative to assist in supervising installation of liquid polymer feed equipment.

D. Provide a minimum of two days service by a fully qualified manufacturer’s service engineer to inspect completed installation, start equipment and place in operation, and train operators in its use and care.

END OF SECTION
PART 1 GENERAL

1.01 DESCRIPTION
A. This section includes requirements for providing high density polyethylene (HDPE) plastic tanks with all accessories and appurtenances as indicated, in accordance with the Contract Documents.

1.02 QUALITY ASSURANCE
A. All work shall be executed and installed in accordance with the applicable requirements as stated herein.
B. Coordinate with ancillary equipment and piping for nozzle connections to provide a complete and functional system.
C. The interior and exterior surfaces of the tanks shall be essentially smooth and free of abrupt surface variations, imperfection, rough or uneven spots, or projections.
D. Shop Tests
   1. Test specimens shall be taken from fitting location areas or piggy-back test molds.
   2. Low Temperature Impact Test
      a. Test specimens shall be conditioned at –40°F for a minimum of 2 hours.
      b. The test specimens shall be impacted in accordance with ASTM D1998. Test specimens <1/2" thick shall be tested at 100 ft-lb. Test specimens >1/2" thick shall be tested at 200 ft-lb.
   3. Ultrasonic Tank Thickness Test: All tanks shall be measured for tank wall thickness at 6-inches, 1-ft, 2-ft, etc. on the tank sidewall at four evenly spaced locations around the tank circumference. All tanks shall meet the design thickness requirements and tolerances.
   4. Hydrostatic Water Tests: All tanks shall be filled to the tank to brim capacity for a minimum of four hours. A visual inspection shall be conducted to confirm that there are no leaks.

1.03 SUBMITTALS
A. Submit shop drawings and other data in accordance with Section SP-09:
   1. Copies of data including full information on basic materials and test data confirming the chemical resistance of the proposed resins to the chemical to be stored.
   2. Complete fabrication drawings including all dimensions and shell thicknesses.
   3. Data indicating the sizes of all major tank components, anchor bolt locations and details., and
   4. Full information and details concerning field assembly and installation.
   5. Complete structural design calculations, prepared and sealed by a professional engineer, demonstrating compliance of the tanks direct integral supports and appropriate accessories with the requirements and criteria of this specification section.
6. Tank data indicating equipment number, pressure rating diameter straight shell length, overall length, wall thickness, and details of nozzle designs and accessories.

7. Data on heat trace and insulation, including heat loss calculations, wiring diagrams, and controls.

8. Certified test data on representative samples of standard materials which verify that their physical properties meet the requirements and service conditions specified.

9. Submit operation and maintenance manuals in accordance with Section SP-10.

10. Special shipping, storage and protection, and handling instructions in accordance with Section SP-14.

11. Manufacturer’s written installation instructions.

1.04 EXTENDED WARRANTY
A. Manufacturer shall warrant each tank for a period of five years for workmanship and chemical compatibility.

PART 2 PRODUCTS
2.01 MANUFACTURERS
A. HDPE plastic tanks shall be as manufactured by:
   1. Poly Processing Company
   2. Snyder Industries
   3. Or Equal.

2.02 DESIGN CRITERIA
A. Capacity: 3,000 gallons (nominal).

B. Dimensions:
   1. Diameter: 7-feet.
   2. Side wall height: 11-feet.

2.03 GENERAL
A. Tanks shall be either cross-linked high density polyethylene of linear high density polyethylene. Manufacturer shall confirm and warrant chemical resistance for the type of tank selected.

B. Construction Material – Cross-Linked HDPE
   1. Tanks shall be constructed from cross-linked high density polyethylene.
   2. The molding powder shall be Marlex CL-200 JN as manufactured by Phillips Petroleum Company Plastics Division, or powders of equal physical and chemical properties.
   3. The plastic shall not contain any fillers. All plastic shall contain ultraviolet stabilizer at a minimum of 0.25% and a maximum of 0.5% (if dry blended) or 2% (if melt compounded) of the total weight of the tank.
   4. Plastics technology specified in this Section shall be in accordance with the definitions given in ASTM D883, unless otherwise noted.
5. The nominal properties of the molded cross-linked HDPE tank material shall be as follows:

<table>
<thead>
<tr>
<th>Property</th>
<th>ASTM Spec.</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Density D1505</td>
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<td>59 lbs./cu. ft.</td>
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<tr>
<td>Specific Gravity --</td>
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<td>0.933 to 0.940</td>
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<tr>
<td>ESCR Spec. D1593</td>
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<td>700 to 1000 hours</td>
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<tr>
<td>Thickness 125 mils, F 50</td>
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<td></td>
</tr>
<tr>
<td>Tensile Strength D638</td>
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<td>2600 psi</td>
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<tr>
<td>Ultimate 2-in/min. Type IV Spec</td>
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</tr>
<tr>
<td>Elongation at Break D638</td>
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<td>400%</td>
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<tr>
<td>2-in/min</td>
<td>Type IV Spec</td>
<td></td>
</tr>
<tr>
<td>Vicat Softening Temperature D1525</td>
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<tr>
<td>Brittleness D746</td>
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<td>-180 degrees F.</td>
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<tr>
<td>Flexural Modulus D790</td>
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<td>100,000 to 110,000 psi</td>
</tr>
</tbody>
</table>

2.04 SINGLE WALL TANKS

A. Tanks shall be flat bottomed, vertical, seamless, and cylindrical.

B. Tanks shall have integral domed top with hinged flap-type manway in top, and bolted, flanged access manway in side.

C. Bottom outlets shall clear interference with containment area floor. Tanks with integrally molded flanged outlets shall rest upon a concrete base pad to obtain the proper clearance.

2.05 ACCESSORIES

A. Flanges: All connections shall be bolted double flanged. All flanges shall be integrally molded. Compression molded or socket type flanges are prohibited. Provide ANSI B16.5, 150 lb flanged and drilled connections in locations shown on the Drawings. All fittings shall be placed away from tank knuckle radius and flange lines. Flanges shall be constructed of PVC Type 1, Grade 1. Gaskets shall be minimum ¼” thickness EPDM, Viton, or other material compatible with the chemical to be stored in the tank. Bolts for flanges shall be encapsulated in Type II polyethylene material. Bolt material of construction shall be compatible with the chemical to be stored in the tank.

B. Access Hatch: A 24-inch I.D. gasketed, threaded access hatch shall be provided at the top as shown on the Drawings.

C. Vents, fill connections, drains, overflow pipes, and outlets shall be provided and located as shown on the Drawings.

D. Provide a siphon tube on the bottom tank connection to allow for complete tank drainage.
E. All tank fitting attachments shall be equipped with PFA expansion joints to allow 4% movement.

F. Provide an interior fill pipe from the fill pipe nozzle to near one-foot off the bottom of the tank, as shown on the Contract Drawings. The interior fill pipe shall be bracketed to the interior of the tank shell. Interior fill pipe shall be constructed of the same materials as the tank. Provide a siphon break above the maximum liquid level to prevent siphoning of liquid through the fill line.

G. Tie Down Lugs
   1. For exterior tanks, provide a minimum of four tie-down lugs integrally molded and equally spaced around the bottom of the tank, predrilled for tank hold-down anchors. The design shall allow direct inner tank base retention for up to seismic zone 4 conditions per UBC code. Tie down system shall be designed to withstand 110 MPH winds.

H. Tank Lifting Lugs
   1. Provide a minimum of three lifting lugs, equally spaced to distribute the load.

I. Ultrasonic Level Gauge
   1. Tanks shall be provided with an ultrasonic level gauge, in accordance with Division 16.

J. Nameplate
   1. Provide a 8-1/2” x 11” 316 stainless steel nameplate with the following information:
      a. Name of tank manufacturer.
      b. Material of construction.
      c. Chemical to be stored including:
         (1) Concentration.
         (2) Specific gravity.
         (3) Maximum temperature.
      d. Tank capacity.
      e. Date of manufacture.

2.06 HEAT TRACE AND INSULATION

A. The sodium hypochlorite tank shall be electrically heat traced to ensure that the contents are maintained at 50°F. Heat loss calculations shall be based upon a minimum ambient temperature of –5°F. The tank is located outdoors.

B. The tanks shall be insulated with a 2-inch layer of foamed polyurethane insulation with an R-12 rating. Provide a 1/8-inch thick FRP skin over the insulation. If required, provide a horizontal expansion joint in the tank to accommodate expansion of the FRP skin.

C. Heating System
   1. The tank shall be heated by using one of more silicone pad type heaters. Each silicone pad header shall operate on 110 VAC, single phase.
   2. Headers shall be low watt density design with a maximum power density of 0.22 watts per square centimeter. The heating panels shall be designed to wrap around and lie flat against the surface of the secondary containment tank.
3. Heaters shall incorporate an aluminum ground shield to fully comply with Article 427-23 (b) of the National Electric Code.

4. Provide an over-temperature cut out switch. The cut out switch shall be factory set to open at 125°F.

5. Heating pad cold leads shall be 16 AWG, 3 conductor, silicone rubber insulated with nickel plated copper overbraid.

6. Heater terminations shall be factory made and potted within a metal connection box.

7. Heating pads shall be supplied with adhesive backing and “peel off” protection. Heater shall be bonded directly to the tank surface.

D. Control System

1. Provide a NEMA 4X controller. Controller shall incorporate two electronic thermostats, switching the heating system via one Solid State Relay.

2. The primary thermostat shall be set to control the temperature of the sodium bisulfite at a minimum of 50°F. The secondary thermostat shall provide over-temperature protection for the heating system. The second thermostat shall be set at 60°F.

3. Temperature sensing shall be performed by two type “J” thermocouples, with FEP insulated leads and stainless steel overbraid.

4. Control enclosure shall provide sufficient terminals for all heating pad and power connections.

5. Provide a single digital output to the plant control system for indication that the heating system is on.

PART 3 EXECUTION

3.01 GENERAL

A. The tank equipment shall be installed in strict accordance with the manufacturer’s instructions in the location shown on the Contract Drawings.

B. Grouting under the tank, if recommended by the tank manufacturer, shall be done in strict accordance with the manufacturer’s instructions and recommendations with non-shrink grout as specified in Section 03300.

C. When installation has been completed and all connections have been made, all tank surfaces, interior and exterior, shall be thoroughly cleaned as recommended by the manufacturer and to the satisfaction of the Engineer. Abrasive cleaning agents shall not be used.

3.02 TESTING

A. The tank shall be hydrostatically tested for leaks by filling with water. Tanks shall be checked for leaks after they have been filled for at least four hours. The Engineer may request that this be performed in his presence at time of tank inspection.

END OF SECTION
SECTION 11336
RESIDUALS CLARIFIER EQUIPMENT

PART 1 GENERAL

1.01 DESCRIPTION
A. Provide one, continuous-feed-type, residuals clarifier mechanism, suitable for installation in the existing solids holding tank, as shown on the contract drawings.
B. The equipment furnished shall include, but not be limited to, the following:
   1. Full-diameter walkway with handrails, center drive platform
   2. Clarifier drive assembly
   3. Feed pipe
   4. Feedwell
   5. Center torque shaft
   6. Sludge collection and thickening arms with rake blades
   7. Clarifier control panel
   8. Effluent launders
   9. All necessary anchor bolts and assembly fasteners.

1.02 RELATED WORK SPECIFIED ELSEWHERE
A. Concrete: Division 3
B. Metals: Division 5
C. Finishes: Division 9
D. Electrical and Controls: Division 16

1.03 REFERENCES
A. American Society of Testing Materials (ASTM):
   1. A36 Structural Steel Specifications
   2. A992 Structural Steel Shapes
   3. 304 Stainless Steel
   4. A325 Structural Steel Bolts
   5. A48 Cast Iron Specifications
   6. A53 Pipe Specifications
   7. A536 Ductile Iron Specifications
   8. A283C Steel Plate Specifications
B. American Iron and Steel Institute (AISI), heat treated steel specifications
C. American Gear Manufacturers’ Association (AGMA), gear ratings
D. American Welding Society (AWS), current standards
E. Anti-friction Bearing Manufacturers’ Association (AFBMA), bearing life specifications
F. National Electrical Manufacturer’s Association (NEMA), motor design standards and standards for control enclosures
1.04 QUALITY ASSURANCE

A. Comply with applicable portions of General Provisions and Section 15050.

B. Provide components that are the standard product of a manufacturer regularly engaged
   in the production of the required materials and equipment.
   1. A single manufacturer or system supplier shall provide the complete clarifier
      equipment and appurtenances.
   2. The manufacturer or system supplier shall be responsible for proper operation of
      all components.

C. Comply with applicable standards including, but not limited to the most recent edition of
   the following:
   1. American Society of Testing and Materials (ASTM)
   2. National Electrical Manufacturers Association (NEMA)
   3. American Welding Society (AWS)
   4. Steel Structures Painting Council (SSPC)

D. Design to provide satisfactory performance under the specified operating conditions.

E. Field-locate and mount the components, pipe and install in accordance with the
   manufacturers recommendation.

F. Manufacturer shall be responsible for the system to perform its intended functions and
   will operate in a satisfactory manner.

1.05 SUBMITTALS

A. Comply with Section SP-09. Include the following information:
   1. Make, model, and weight of each equipment component including
      appurtenances.
   2. Manufacturer’s catalog information that describes each item provided. Include:
      a. Complete specifications
      b. Complete bill of materials that identifies all materials of construction.
      c. Description of operation
      d. Control schematics and wiring diagrams.
   3. Certified structural, mechanical, electrical, and erection drawings. Show:
      a. Construction details,
      b. Fabrication drawings,
      c. Equipment dimensions,
      d. Electrical interconnection diagram
      e. Size and location of anchor bolts, and
      f. Locations of connections to other work.
   4. Special shipping, storage, protection, and handling instructions.
B. Submit Operation and Maintenance Manuals in accordance with Section SP-10. Include:
   1. A list of manufacturer’s recommended parts required to maintain each equipment item for a period of one year, with current price information.
   2. A list of special tools, materials, and supplies furnished with each equipment item for use prior to and during startup, and for future maintenance.
   3. Manufacturer’s installation instructions.
C. Submit manufacturer’s certificates in accordance with the Section SP-08.

1.06 PRODUCT DELIVERY, STORAGE AND HANDLING
A. Deliver, handle, and store the equipment in accordance with Section SP-14.
B. Implement manufacturer’s long term storage and handling procedures if equipment will be stored longer than 2 months before it is installed and placed into operation.

1.07 SPECIAL TOOLS AND SPARE PARTS
A. Furnish one complete set of special tools required to disassemble, service, repair, and adjust the equipment.
B. The clarifier manufacturer shall supply spare parts as recommended by the manufacture, including the following:
   1. One set of seals for the clarifier drive
   2. One set of overload control device switches
   3. One set of squeegees
   4. One oil sight glass

PART 2 PRODUCTS
2.01 GENERAL
A. Residuals clarifier equipment shall be manufactured by Siemens Water Technologies, WesTech, EIMCO, or equal
B. Install the clarifier mechanism in the existing tank. Tank is approximately 35-feet in diameter, 17.5-feet- side water depth, 2-feet-free board, and a floor slope of 3 inches in 12 inches.
C. The clarifier mechanism shall be
   1. Center-drive type
   2. Supported by the walkway access bridge resting on the basin walls.
D. The mechanism shall be designed to receive spent filter backwash and clarifier blowdown, mechanically rake the thickened solids from the tank floor to the basin center for removal. The clarified effluent shall be collected uniformly by the peripheral launder.
E. Blended residuals shall enter the clarifier through an influent pipe and discharge into a feedwell for energy dissipation. Solids shall settle to the floor of the clarifier and thickened with rotating pickets. Settled solids shall be raked to the center of the clarifier.
F. Each clarifier mechanism component shall be designed to withstand all stresses that may occur during fabrication, erection, intermittent, or continuous operation.
G. Except where specifically indicated otherwise
   1. All plates and structural members designated for submerged service shall be 0.25-inch-thick.
2. All non-structural members shall be 3/16-inch-thick.
3. All structural steel shall conform to ASTM A-36 requirements. Steel plate shall conform to ASTM A283C requirements. Steel pipe shall conform to ASTM A-53 Grade B designation.
4. All anchor bolts, assembly fasteners, handrail and rake blade squeegee fasteners shall be 304 stainless steel.

2.02 DESIGN CRITERIA

A. Design parameters are as follows:
   1. Design Influent flow rate 1,800 gallons per min (gpm)
   2. Drive (Alarm) 12,000 feet-pound (ft-lb)
   3. Drive (Motor Shut-Off torque) 15,480 ft-lb
   4. Drive (Shear Pin torque) 16770 ft-lb
   5. Mechanism rotation Clockwise
   6. Sludge collection arm tip speed 0.05 rotation per minute (rpm)

2.03 CLARIFIER CENTER DRIVE ASSEMBLY

A. The center drive assembly shall consist of
   1. Motor and primary speed reducer
   2. Roller chain
   3. Secondary worm-gear reducer
   4. Integral overload protection system

B. Gears
   1. Oil-bath-lubricated, with the rolling elements of the main bearing totally submerged in oil and the teeth of the worm gear partially submerged in the oil bath.
   2. The meshing action of the gears shall force the oil onto all surfaces.
   3. Oil pumps will not be allowed.
   4. The oil reservoir for the main bearing and gear shall have a minimum depth 2 inches below the main bearing to positively prevent contamination of the main bearing and gears.
   5. Gear and bearing housings shall be fitted with oil level sight glasses and condensate drains. Condensate shall drain from low point of the housing.

C. Drive components will be located via a machined, registered fit to preserve the alignment of key drive components under all load conditions. Inspection of the completed drive unit shall be accomplished at the clarifier manufacturer's shop, with reports of all tests and certifications of material hardness reviewed by the Engineer prior to shipment to the job site.

D. Major drive components, worm gears and bearings shall be designed for separate, individual replacement by plant personnel.

E. The complete center drive assembly, including the overload protection device, shall be a regularly manufactured in-house product of the clarifier manufacturer.
F. Motor
1. 0.75 horsepower, totally enclosed and fan cooled (TEFC) motor
2. 1.15 service factor
3. Bearings with minimum B10 rating of 50,000 hours.
4. 460-volt, 3-phase, 60-hertz, electric supply.

G. The gearmotor primary-speed reducer shall drive the final worm gear reducer through a #80 roller chain and steel sprockets enclosed in a galvanized 22-gage sheet metal guard. Sprockets and chain shall be designed for the connected horsepower of the drive with a minimum service factor of 2.0. Provisions shall be made for adjustment of chain tension.

H. Final reducer shall be a worm-and-worm-gear-reducer specifically designed for this application. The worm shall be hardened alloy steel.

I. The worm gear rim shall be solid, one-piece-centrifugal-cast, manganese bronze of 65,000 PSI tensile strength and have a nominal 22-inch pitch diameter. Worm gear shall be supported by, and rotate on, the main bearing. The rotating center shaft to which the rake arms are attached shall be bolted to the worm gear hub. The gear shall be removable without disturbing the walkway or platform. Gear diameter must be increased in size for cast iron gears.

J. The main bearing shall have a minimum pitch diameter of 17 inches and shall include chrome alloy steel balls, minimum 0.50-inch-diameter, which shall bear vertically and horizontally upon a four-point-contact-precision-bearing assembly fitted into the turntable base and the worm gear. B10 life of the liner shall be a minimum of 50 years based on the mechanism speed and a uniformly distributed load.

K. Drives using integral bearing / gear assemblies will not be allowed.

L. The worm gear and bearing shall be completely enclosed in a housing provided with neoprene dust seals.

M. The drive unit shall be equipped with an electro-mechanical overload control device actuated by thrust from the worm shaft. The pointer shall provide a visual reading of the relative worm gear output torque on a zero to 100-percent graduated scale. The 100-percent reading shall equal the 100 percent drive rating specified in section 1.03. The control device shall also activate an alarm switch for warning of impending overload, a motor cutout switch for overload protection and a back-up safety motor cutout switch for back up overload protection. The respective switches in the overload control device shall be factory calibrated and set to the following settings;
   1. Alarm; 100 percent of scale.
   2. Motor cutout; 120 percent of scale.
   3. Shear pin cutout; 130 percent of scale.

N. All drive control components shall be mounted in a weatherproof, stainless steel, cast iron, or epoxy-coated aluminum enclosure with a gasket-sealed removable cover. The pointer shall be covered with a clear plastic enclosure and shall be above the walkway surface for visibility.

O. The center drive unit shall be designed for the continuous torque rating as specified in section 1.03. The continuous torque shall be defined as the minimum torque at which the drive mechanism may operate continuously 24 hours per day, at the specified sludge collector arm speed.
P. Worm gearing shall be designed and rated to equal or exceed the specified continuous torque and life. The basis for rating shall be ANSI/AGMA 6034-B92.

2.04 INFLUENT PIPE
A. Influent pipe shall be Schedule 40 steel.

2.05 WALKWAY ACCESS BRIDGE AND OPERATING PLATFORM
A. Access to the center operating platform surrounding the drive assembly shall be provided by means of a 36-inch-clear, open-width, walkway. The walkway shall span the entire tank and be supported by the tank walls. As a minimum, the walkway shall be designed to withstand all dead loads, plus a live load of 50 pounds-per-square-foot with a maximum deflection of l/360, over the entire span. The walkway shall consist of two, wide-flange beams. Beams shall be sufficiently braced to resist the specified design loads. The walkway will be covered with 1.25-inch by 3/16-inch, aluminum, I-bar grating.
B. A center drive platform shall be provided. There shall be a minimum 2-foot clearance around the drive components. The drive platform shall be covered with 1.25-inch by 3/16-inch, aluminum, I-bar grating and have sufficient structural steel supports to meet the specified design load conditions.
C. Handrails with toe plate shall be provided along both sides of the walkway and around the center drive platform. The handrail shall be 1.5-inch-diameter, aluminum pipe, 2-rail design, with fittings factory assembled to posts. The toe plate shall be a 4-inch by ¼-inch plate or a 4-inch-tall aluminum extruded channel.

2.06 CENTER TORQUE SHAFT
A. The center torque shaft shall be constructed of 6-inch-diameter, Schedule 80 steel pipe.
B. The center torque shaft shall be attached to the output shaft of the drive and shall be provided with connection points to support two sludge collection and thickening arms and feedwell supports.

2.07 SLUDGE COLLECTION AND THICKENING ARMS
A. The clarifier mechanism shall include two sludge collection and thickening arms of steel truss construction with steel raking blades, steel sludge thickening pickets, and adjustable, 304-stainless-steel squeegees. Sludge collection and thickening arms will be attached to the clarifier drive mechanism by means of a steel torque shaft. Support tie rods in the sludge collection and thickening arm design will not be allowed. Rake blades shall be properly spaced to ensure complete raking of the tank bottom twice per revolution.
B. The sludge collector arms shall be designed such that calculated stresses do not exceed the AISC-allowable stress at twice the drive 100-percent rating.
C. Rake blades shall be provided on each sludge collection and thickening arm.
D. Adjustable 20-gage, 304 stainless steel squeegees shall be attached to the bottom of rake blades. Squeegees shall extend 1.5 inches below the rake blades and attached with stainless steel bolts.
E. Sludge thickening pickets shall be attached to the sludge collection and thickening arms to promote proper sludge thickening. Pickets shall extend from the tops of the rake blades to the top of the sludge collection and thickening arm truss at its highest point.

2.08 FEEDWELL
A. The feedwell shall be 8-feet-diameter with a 6-foot side depth.
B. Feedwell shall be minimum 3/16-inch thick. Support will be provided by brackets attached to the torque shaft. All necessary reinforcing rim angles, stiffeners, and supporting brackets shall have a minimum thickness of 1/4 inch.

2.09 WELDING
A. All welding practices shall be in accordance with the requirements of the AWS current standards. All welders shall be certified in accordance with AWS.

2.10 SURFACE PREPARATION AND PAINTING
A. All non-submerged steel shall be commercially blast cleaned to SSPC surface preparation (SP) -6 specifications and given one coat of manufacturer's epoxy primer 2-3 minimum dry film thickness (MDFT). All submerged steel shall be near-white blasted to SP-10 specifications and given one coat of manufacturer's epoxy primer, 2-3 MDFT.

B. Gear motors shall be furnished with manufacturer's standard enamel.

2.11 EFFLUENT LAUNDER SYSTEM
A. The effluent launder system shall be constructed of 304 stainless steel and should be a minimum 12 inches wide and a minimum 12 inches deep. Sizing of troughs will be such that a minimum freeboard of 2 inches is maintained at 1,800 gpm.

B. Effluent launder shall be anchored to the existing concrete tank walls by means of 304 stainless steel, epoxy-type-anchor bolts and washers. Bolted launder connections shall include continuous neoprene gaskets. Supports shall be designed to provide vertical and horizontal adjustment.

C. Trough manufacturer shall be responsible for structural design of troughs and shall provide stiffeners and reinforcing as necessary. Troughs will be manufactured of minimum 3/16-inch-thick 304 stainless steel plate and supports of minimum ¼-inch-thick. Deflection of all members is limited to l/360.

D. Launder shall include an outlet pocket or drop box with a minimum 12-inch plain-end steel discharge pipe.

2.12 CONTROL PANEL
A. A control panel shall be provided for the clarifier mechanism.

B. The control panel shall be of stainless-steel construction conforming to NEMA 4X requirements and suitable for handrail mounting.

C. A hinged front door shall be provided on the control panel adequately sized to contain all of the required controls with access for repairs.

D. The control panel shall have a 120-volt, single-phase, 60 hertz, power supply.

E. The control panel shall be factory wired and tested with clearly identified, industrial type terminal strips for all external field connections.

F. An industrial type alarm horn shall be supplied to indicate a high torque situation.

G. The following indicators and control devices shall be mounted on the front of the panel:
   1. Clarifier drive "ON-OFF" selector switches
   2. Pilot light
   3. Mechanism "RUN" indicating light

H. Motor starters per 16155.
PART 3 EXECUTION

3.01 INSTALLATION
   A. Install all equipment in strict accordance with manufacturer instructions. Drill and epoxy all anchor bolts, frames and other items into concrete work, as required.
   B. Provide all temporary safety devices, supports and bracing to prevent damage to and overloading of any structure during installation.
   C. Provide all appurtenances, fittings, connecting piping and accessories which are not specifically provided by Suppliers but which are necessary for the proper functioning of the equipment.
   D. Supply all necessary shims, gaskets, etc. and all necessary lifting and loading equipment and tools, required to complete the installation.
   E. All weirs, troughs, baffles, skimmers, shall be precisely set to given grades and elevations relative to structures and water surfaces. Check and confirm the proper placement of weirs, troughs, baffles, skimmers and overflow devices by filling the clarifier with water to the elevations necessary to obtain this check and confirmation.
   F. Lubricate all equipment in accordance with supply Contractor's instructions.
   G. Fill equipment with grease and oil as required for the initial operation.

3.02 FIELD PAINTING
   A. Protect surfaces coming into contact with the pumped liquid, other than stainless steel.
      1. As specified in Section 09900.
      2. Repair coatings damaged during shipment, storage or installation.

3.03 PERFORMANCE TESTING
   A. Torque Tests: The entire sludge collector mechanism shall be statically load tested by individually loading each rake arm with 150 percent of the specified design running torque. The test shall verify the torque overload control device settings for alarm and motor cutout. Each arm shall be individually anchored and the load measured to demonstrate the rake arms', cage's, and drive unit's ability to withstand the specified torque. Sketches and calculations shall be submitted illustrating how the torque will be applied prior to testing.

3.04 PROCESS PERFORMANCE TESTING
   A. The mechanism shall be operated in a dry tank for a minimum of 4 continuous hours before flow is allowed to enter the system. There shall be no binding, jerky, or unusual motion exhibited during this run-in period. Motor amperage shall be checked at least hourly for any unusual or higher-than-normal figures. After the unit has successfully passed this initial test, flow shall be introduced into the tank and the same 4 hour observation test run. If the unit should fail under any of these conditions, the test shall be halted and the problem corrected. If, after several attempts, the unit does not successfully pass the field test, the faulty portion of the equipment shall be repaired or replaced and the test re run.

3.05 MANUFACTURER'S FIELD SERVICES
   A. Provide manufacturer's field services in accordance with Section SP-18.
   B. Training
      1. Provide sixteen hours to instruct Owner.

END OF SECTION
SECTION 11400
VERTICAL FLOCCULATOR

PART 1 GENERAL

1.01 DESCRIPTION
A. Provide vertical paddle-wheel flocculator, including drive system and accessories as shown on the Contract Documents.

1.02 QUALITY ASSURANCE
A. Comply with applicable portions of General Provisions and Section 15050.
B. Comply with following standards:
   1. American Bearing Manufacturers Association (ABMA):
      a. 9, Load Ratings and Fatigue Life for Ball Bearings.
      b. 11, Load Ratings and Fatigue Life for Roller Bearings. American Gear
   2. American Gear Manufacturers Association (AGMA):
      b. 6001-097, Design and Selection of Components for Enclosed Gear Drives.
      c. 6010-F97, Standard for Spur, Helical, Herringbone and Bevel Enclosed Drives.
   4. American Society of Mechanical Engineers (ASME):
      a. B1.20.1, Pipe Threads, General Purpose (Inch).
   5. ASTM International (ASTM)
   6. National Electrical Manufacturers Association (NEMA): MG 1, Motors and Generators.
   7. The Society for Protective Coatings (SSPC).
C. Manufacturer shall be responsible for complete system including the paddle-wheel flocculator, and drive system.

1.03 SUBMITTALS
A. Comply with Section SP-09.
B. Submit shop drawings and product data for flocculation equipment as specified herein:
   1. Process calculations, mechanical and structural calculations, and drawings.
   2. Process calculations (velocity gradient, tip speed, horsepower requirements, and paddle arrangement).
   3. Manufacturer’s literature, illustrations, specifications, and engineering data including total weight of each unit, structural loads, connection details, and performance data.
4. Drawings shall show dimensions, overall arrangement of equipment and materials of construction.
5. Control diagrams and panel layout.

C. Submit manufacturers’ certificates in accordance with Section SP-08.
D. Submit Operation and Maintenance Manuals in accordance with Section SP-10.

1.04 PRODUCT DELIVERY, STORAGE, AND HANDLING
A. Deliver, handle, and store the equipment in accordance with Section SP-14.

1.05 SPECIAL TOOLS
A. Provide special tools as recommended by the manufacturer.

PART 2 PRODUCTS

2.01 MANUFACTURERS
A. Jim Myers & Sons, Inc.,
B. Or equal

2.02 SERVICE AND DESIGN CONDITIONS
A. Design Criteria:
   1. The equipment shall be designed to accomplish flocculation in the Superpulsator influent box, without shearing or destabilizing the agglomerated floc particles.
   2. Size equipment as required to work in the Superpulsator influent box, as indicated on the drawings.
   3. Design conditions:
      a. pH: 5.5 to 8
      b. Water temperature: 50 to 85°F
4. Design criteria:

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<td>Number of Drives Required</td>
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<tr>
<td>Approximate Size of Blades (inch x inch)</td>
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<tr>
<td>Maximum Tip Speed (feet per second(fps))</td>
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<tr>
<td>Minimum Motor Horsepower (horsepower (hp))</td>
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2.03 SHAFTING SYSTEM

A. Shafts.
1. Designed within stress limitations at full operating load.
2. Maximum shear stress not exceed 6,000 pounds per square inch (psi).
3. Type 304L stainless steel hubs of ½-inch minimum thickness welded (continuous) to the shafts for paddle arm connection.
4. Adequately sized to transmit the required torque at full speed, manufactured from solid Type 304L stainless steel with 2-7/16 inch thickness minimum.
5. keyed on one end and flanged on the other end. Install a minimum of 4 gusset plates shall be installed at the flange to reinforce the connection.
6. Provide paddle reel shafting of Type 304L stainless steel hollow shafting, straight and true with flanges on both ends for a bolted connection between the drive shaft and idle end shaft.
7. Provide standard 150lb ANSI flanges manufactured from Type 304L stainless steel. A minimum ¼-inch-thick neoprene gasket shall be placed between each set of flanges. After fabrication, each shaft assembly's flange shall be faced to within 0.015-inch of parallel to one another. Solid shaft flanges shall be faced to within 0.015-inch of perpendicular to the axis of the shaft.

B. Bearings
1. The solid drive shaft shall be connected to the output shaft of the gear reducer by a flexible chain coupling, and shall be supported by a heavy-duty radial thrust roller bearing and thrust collar mounted on the drive support base. The roller bearing will be dynamically self-aligning.
2. The thrust bearing assembly shall be independent of the gear reducer and no external or overhung loads shall be imposed on the gear reducer. Flocculator designs that direct couple the flocculator shaft to the gear reducer without a separate thrust bearing assembly are not acceptable.

C. Flocculation Paddle Assemblies
1. The flocculator paddles shall be nominal 2-inch by 6-inch pultruded fiberglass channel manufactured with National Science Foundation (NSF)-61 approved polyester resin. Paddles shall be bolted to paddle arms with two ½-inch bolts and nylon insert lock nuts at each connection. All cut edges and holes in the fiberglass paddles will be resin sealed.

2. The paddles shall be held in place and supported by stainless steel angle arms bolted to the fabricated stainless steel shaft hubs with two 5/8-inch bolts and nylon insert locknuts. The paddle arms shall be sized for a tip deflection of no more than 1/360, and shall be no smaller than L3 x 3 x ¼-inch angles.

2.04 DRIVE SYSTEM
A. Drive Motor
1. Integral gearmotors shall be energy-efficient, squirrel-cage, induction-type with totally enclosed fan-cooled frames.

2. Insulation shall be class F minimum with 120-volt windings, space heaters, and thermostat overload protection embedded in the windings. Maximum temperature rise above ambient shall not exceed the value specified for Class B rise.

3. Applicable for 460-volt, 3-phase, 60-hertz, electrical supply.

4. Provide premium efficiency type motor.

5. Service factor of 1.15.

6. Oil or grease lubricated anti-friction bearings have a minimum of L-10 life of 80,000 hours, as defined by AFBMA.

7. The rating of motors shall be adequate to continuously drive the flocculator under any condition of operation but shall not be less than specified above.

B. Variable Frequency Drive (VFD)
1. Electrical variable frequency drive shall be integrally mounted on a common frame with the drive and gear reducer.

2. Frequency adjustment shall be local to the motor and suitable for the environment of installation.

3. Comply with Specification Section 16157 for VFD requirements.

C. Gear Reducers
1. Designed in accordance with AGMA.

2. Drive units shall be as manufactured by SEW Eurodrive and contain wash down duty features.

3. Each drive unit shall be constant speed and designed to provide speed and output torque as required by process design. The gearbox will be parallel helical or helical bevel gearing as required by site constraints.

a. Gearbox will be RM series or equal to provide additional bearing.

4. Each drive unit shall be designed and arranged for rotation as indicated on the drawings.
5. Each gear reducer shall be a heavy-duty, foot-mounted, concentric gear unit completely enclosed in a housing of cast iron or fabricated steel construction.

6. The gear reducer shall be specifically designed for the application intended and shall be suitable for connection to the output shaft.

7. The gear reducer shall be designed and rated for a minimum of AGMA II with a service factor of 1.4 applied to the motor nameplate rating.

8. The thermal rating of gear reducer shall exceed the design mechanical rating to preclude the need for external cooling equipment. External cooling devices are not acceptable.

9. The gear reducer output shaft shall be constructed and supported so that the shaft deflection caused by the operating loads does not affect alignment of the reducer bearings or cause misalignment of the gearing during operation of the flocculator.

10. All bearings in the speed reducer shall be anti-friction type and shall have a minimum L-10 life of 80,000 hours. The units shall be oil lubricated. All gears and bearings shall be protected from rusting during storage by the application of a shop-applied protective coating.

D. Drive Stand Assembly

1. The drive stand assembly shall be manufactured from Type 304L stainless steel consisting of a drive stand and drive support plate. The drive support plate shall be a minimum of ½-inch thick, and bolts to the drive stand which shall have a minimum material thickness of ¼-inch.

2. The drive stand shall be designed and reinforced to withstand all loads, torsional and vertical, applied by rotating forces of the flocculation equipment operating at full speed.

3. The drive stand shall allow for the mounting of the drive base plate, radial thrust bearing, and thrust collar.

2.05 HARDWARE

A. Comply to applicable portions of 03300 and 15050.

B. All field assembly bolts and anchor bolts, nuts, and washers will be Type 316 stainless steel.

2.06 FABRICATION

A. All welded joints that will be fully or partially submerged will be sealed watertight with continuous welds. All welding will be performed in accordance with AWS standards.

B. All parts and components shall be factory-assembled in sections convenient for field handling and installation. Any field assembly work shall be bolted. No cutting or welding shall be required on either field assembly or erection.

C. Gears and gear drives as part of an equipment assembly shall be shipped fully assembled for field installation.

D. All assembled parts and components ready for shipment shall be securely bundled, coiled, or crated and adequately protected from damage and corrosion during shipment and storage.

2.07 SURFACE PREPARATION

A. Stainless steel, aluminum, fiberglass, and UHMW-PE shall not be painted.
B. All stainless steel surfaces, except in bearing areas, shall be brush blasted in accordance with SSPC-SP7 before shipment.

C. Mechanical components, such as drive unit and bearing shall be painted in accordance with Section 09900.

PART 3 EXECUTION

3.01 INSTALLATION
A. Install the flocculation equipment in accordance with the manufacturer’s drawings and recommendations.

B. Power and control wiring shall be specified in Division 16.

3.02 FIELD QUALITY CONTROL AND TESTING
A. Perform field inspection and testing in accordance with Section 01650.

3.03 MANUFACTURER’S FIELD SERVICES
A. Provide manufacturer’s field services in accordance with Section SP-18.

B. Have manufacturer’s representative check and verify installation of equipment is in accordance with Drawings and manufacturer’s installation instructions prior to starting equipment and provide installation certificate.

C. Provide factory trained manufacturer’s representative to assist in supervising installation of flocculation equipment.

D. Provide a minimum of two days service, by a fully qualified manufacturer's service engineer to inspect completed installation, start equipment and place in operation, and train operators in its use and care.

END OF SECTION
SECTION 11500
SUBMERSIBLE MIXER

PART 1 GENERAL
1.01 DESCRIPTION
A. Provide submersible mixer and appurtenances in the Blend Tank, as specified and as shown on the Contract Documents.

1.02 QUALITY ASSURANCE
A. Comply with applicable portions of General Provisions and Section 15050.
B. Provide components that are the standard product of a manufacturer regularly engaged in the production of the required materials and equipment.
C. Provide submersible mixer and appurtenances from a single manufacturer.
D. Mixer manufacturer shall be responsible for the design, construction, and proper operation of all components.
E. Assemble and test all components before shipment.
F. Design to provide satisfactory performance under the specified operating conditions.
G. Design for continuous-duty operation.
H. Design to prevent the settling of suspended solids.

1.03 SUBMITTALS
A. Comply with Section SP-09. Include the following information:
   1. Make, model, horsepower, and weight of mixer assembly.
   2. Manufacturer’s catalog information that describes submersible mixer provided. Include:
      a. Specifications
      b. A complete bill of materials that identifies all materials of construction
      c. Control schematics and wiring diagrams
      d. Mounting requirements
      e. Available adjustments
   3. Sizing calculations
      a. Demonstrate acceptable performance for specified operating conditions.
      b. Size each mixer and mounting assembly and indicate the following:
         (1) Minimum force required to remove mixer
         (2) Full load and locked rotor current draw
         (3) Motor horsepower
   4. Certified structural, mechanical, electrical, and erection drawings. Show:
      a. Important details of construction
      b. Equipment dimensions
      c. Size and location of anchor bolts
d. Locations of connections to other work

5. Special shipping, storage, protection, and handling instructions.

6. A list of manufacturer’s recommended parts required to maintain the equipment for a period of 1 year, with current price information.

7. A list of special tools, materials, and supplies furnished with the equipment for use before and during startup, and for future maintenance.

B. Manufacturer’s installation instructions.

C. Lubrication instructions.

D. Submit compliance certificates for specified tests.

E. Submit operation and maintenance manuals in accordance with Section SP-10.

   1. Prepare manual specifically for the type and model of submersible mixer provided.
   2. List the manufacturer’s recommended parts required to maintain the equipment for a period of 1 year, with current price information.
   3. List the special tools, materials, and supplies furnished with the equipment for use before and during startup, and for future maintenance.
   4. Provide manufacturer’s installation instructions. Include instructions for aligning, adjusting, calibrating, and checking each unit.

F. Submit manufacturer’s certificates in accordance with Section SP-08.

G. Factory test each mixer for proper alignment, quiet operation, proper connection, mixing capacity, and satisfactory performance.

H. Submit certified test reports.

1.04 PRODUCT DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, and handle the equipment in accordance with Section SP-14.

B. Preparation for shipment:

   1. Factory-assemble into components as large as practical.
   2. Package and tag unassembled parts to protect them from damage and to facilitate assembly in the field.
   3. Do not dismantle factory-assembled parts and components without written permission from the Owner.
   4. Ship and handle all components to prevent damage and to protect from exposure to the elements.
   5. Store all components and assemblies in a clean, dry, protected location.

C. Protect parts from damage or deterioration during prolonged storage. Clearly mark each box or package to identify its contents and show its net weight.

D. Follow manufacturer’s storage and temporary support recommendations. Protect components from contamination by dust, dirt, vibration and moisture.

E. Store motors and gear reducers in a fully enclosed building or trailer. The storage enclosure shall have a concrete or wooden floor, a roof, and full closed walls on all sides.

F. Protect unpainted iron or steel surfaces to prevent rust and corrosion.

G. Repair or replace damaged material and equipment as directed by the Owner or
1.05 SPECIAL TOOLS AND SPARE PARTS

A. Provide spare parts recommended by the manufacturer. At a minimum, provide two complete sets of the following spare parts for each mixer provided:
   1. Gaskets
   2. Inner and outer seals
   3. Wear bushings, keys, and bearings for both the propeller and the motor end
   4. Power cable grommet

B. Furnish one complete set of special tools required to disassemble, service, repair, and adjust the equipment. A special tool shall be any item, such as Snap-On or Mac tools, that is not readily available through a commercial tool supplier.

C. Provide a 1-year supply of all lubricants as recommended by the manufacturer.
   1. Include summer and winter grades.
   2. Provide alternative lubricant references for equal products of other manufacturers. Include applicable specifications such as AGMA number and viscosity.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Flygt – Model 4620
B. EMU-Wilo
C. or equal

2.02 GENERAL

A. Design equipment to be raised, lowered, angled, and removed for inspection or service without requiring personnel to enter the tank in which it is installed.
   1. Provide guide rail system to mount mixers inside tank.
   2. Mixer shall be angled and locked into position to optimize flow and energy delivery.
   3. Provide an integral hoist that is capable of removing the mixer without draining the tank.
   4. Include lifting lugs on the mixer to facilitate its removal.
   5. Provide all required foundation bolts, plates, nuts, and washers.
      a. Use Type 304 stainless steel unless otherwise specified.
      b. Grout under the bases after the equipment has been set.

B. Design equipment to operate continuously and produce a uniform slurry within the tank, without vibration.
   1. Prevent solids accumulations on the tank bottom and in the corners.
   2. Mixer shall not induce vortexing at the surface or entrain air bubbles in the wastewater.

C. Provide a permanently attached, stainless steel nameplate for each mixer with the
following information:
1. Mixer shall Manufacturer’s name
2. Serial number
3. Model number
4. Horsepower
5. Speed
6. Motor voltage and amperes
7. Other pertinent data as appropriate

2.03 SERVICE AND DESIGN CONDITIONS

A. BLEND TANK
1. Tank contents: Filter backwash and clarifier blowdown
2. Approximate Total suspended: 2,200 milligram per liter solids (TSS) (mg/L)
3. Number of mixers: 1
4. Approximate Horsepower: 2.3
5. Tank dimensions: 15-feet wide by 15-feet long by 23-feet deep
6. Tank volume: 19,000 gallons

2.04 MIXER

A. Close-coupled, direct-drive, submersible type. Mixer shall be:
1. Capable of continuous underwater operation.
2. Capable of operating in air (completely unsubmerged) for at least 2 hours without any deterioration or damage to the mixer.
3. Mating surfaces shall be machined and fitted with nitrile rubber O-rings.
4. Secondary sealing compounds, such as rectangular gaskets, elliptical O-rings, grease, or other devices, shall not be allowed.

B. Materials
1. Mixer shall be Type 304 stainless steel.
2. Propeller shaft shall be Type 420 stainless steel.
3. Wetted parts not constructed of stainless steel shall be coated with a suitable double-epoxy coating system.

C. Motor Cable Entry
1. Cable entry shall be an integral part of the stator casing.
2. Provide leak-proof, torque-free seal at the cable entrance consisting of at least the following:
   a. Two cylindrical elastomeric grommets, flanked by washers.
   b. Ferrule designed with close tolerance fit against the cable outside diameter and the entry inside diameter.
      (1) Assembly shall bear against a shoulder in the stator casing opening and be compressed by a gland nut threaded into it.
(2) The gland nut and ferrule shall move the grommet along the cable axially.

3. Separate the junction chamber and motor compartment by a terminal board to protect the motor interior from foreign material.
   a. Connection between the cable conductors and the stator leads shall be threaded compressed-type binding posts.
   b. Binding posts shall be permanently affixed to the terminal board.

4. Provide a motor cable suitable for submerged operation.
   a. Conform to NEC specifications for pump motors.
   b. Provide sufficient cable to allow the mixer to be raised and lowered over the entire vertical length of the mast.

D. Motor

1. Comply with Division 16.
2. Squirrel-cage, induction-type design.
   a. House in an air-filled, water-tight chamber designed for 20-foot submergence.
   b. Motor housing shall be gray cast iron.
   c. Provide either stainless steel jacket or a suitable double-epoxy coating.
   d. Do not exceed nameplate horsepower rating under any condition.
   e. Motor shall be ISO 9001 certified.
3. Provide premium-efficiency, single-speed motor suitable for operation on a 480-volt, 60-hertz, 3-phase power supply.
   a. Design for continuous operation.
   b. Design to be capable of ten starts per hour.
   c. Provide moisture-resistant, Class H insulation able to resist temperatures up to 311 degrees Fahrenheit.
      (1) Trickle impregnation, or
      (2) Add sufficient stator insulation by adding it to a heated and slowly rotating stator.
   d. Construct the rotor bars and short-circuit rings of aluminum.
   e. Provide at least two bi-metallic thermal sensors, in series, to monitor temperature.
      (1) Mount in the stator winding end turns.
      (2) Wire into the mixer control.
      (3) Sensors shall supplement external motor over-current protection in the control panel.
4. Directly connect the motor to the propeller shaft. Construct the motor shaft of AISI 4340 steel.
5. Support the mixer motor shaft on two, permanently-lubricated bearings.
   a. Use single-row, angular contact ball bearing for the inner bearing.
b. Use single-row, roller bearing for the outer bearing.
c. Provide minimum AFBMA L-10 life of 40,000 hours at full load.

E. Seals
1. Provide two sets of seals running in oil reservoirs for cooling and lubrication.
   a. Provide a lapped end, face-type mechanical seal on the propeller end of the shaft.
      (1) Use mechanical seal with one stationary and one, positively driven, rotating silicon or tungsten carbide face ring.
      (2) Expose only the seal faces of the outer seal and its retaining clip to the tank contents.
   b. Provide a lapped end, face-type mechanical seal or a radial shaft, lip seal to isolate the propeller shaft oil chamber from the dry motor stator housing.
   c. Mechanical seals shall not require maintenance or periodic adjustments.
      (1) Mechanical seals shall be ISO 9001 certified.
2. Oil Chamber
   a. Provide with a drain and inspection plugs.
   b. Provide positive anti-leak seal.
3. Seal Housing
   a. Type 316 stainless steel.

F. Moisture Probes
1. Provide at mixer to sense seal leakage.
2. Electrical relay shall shut down the unit and actuate an alarm, if moisture is detected.

G. Propellers
1. Construct of Type 316 stainless steel.
2. Three-vane design.
   a. Non-clogging type capable of handling solids, fibrous materials, heavy sludge, and other materials generally found in mixed liquor applications.
   b. Backward-curved design.
   c. Dynamically balance.
   d. Secure the propeller to the shaft using a single-screw washer and sleeve.
3. Provide jet rings.

2.05 GUIDE RAIL SYSTEM
A. Provide to mount each mixer during operation and to guide the unit during installation and removal for maintenance and servicing. Include the following components:
1. Bottom bearing console
2. Stop console
3. Guide pipe (mast)
4. Fixing bracket
5. Guide holder assembly

B. Construct all major components of Type 316 stainless steel.

C. Bottom Bearing Console
   1. Bolt to tank floor and use to support the mast.
   2. Provide a receptacle to accept the guide bottom pivot.
   3. Type 316 stainless steel.

D. Guide Pipe (Mast)
   1. Size and brace to withstand all loads induced by the mixer.
   2. Mixer shall be hung from top of mast using an adjustable length stainless steel wire rope.
   3. Provide receptacle to securely hold and support the hoist assembly while mixer is raised, lowered, installed, or removed from the tank.
   4. Mast and wire rope shall be constructed of Type 316 stainless steel.

E. Upper Guide Holding Assembly
   1. Assembly shall provide lateral support for the guide pipe.
   2. Provide ability to reposition mixer guide rail over a horizontal arc of at least 270 degrees and lock into position.
   3. Provide means to secure motor electrical cable.
   4. Provide receptacle to securely hold and support the hoist assembly while mixer is raised, lowered, installed, or removed from the tank, if not provided as part of the guide pipe (mast).
   5. Assembly shall be Type 316 stainless steel, as appropriate.

2.06 HOIST ASSEMBLY

A. Provide a removable, portable crane and hoist assembly for each mixer to raise and lower the unit for maintenance.
   1. Provide sufficient height such that the mixer can be removed from the tank and placed on the adjacent concrete walkway.
   2. Hoist assembly shall pivot over at least a 270-degree horizontal arc.

B. Include the following components:
   1. Telescoping crane arm
   2. Geared hand winch with safety brake
      a. Design winch such that a portable (plug-in) electric motor may be used to raise and lower the mixer.
   3. Stainless steel cable and hook.

C. Provide minimum ¼-inch-diameter, Type 304 stainless steel cable for lifting the mixer.
   1. Sleeve or weld the hoist end of each cable to prevent fraying.
   2. Attach cable to the mixer.

D. Provide portable (plug-in) electric motor suitable for use with the geared hand winch.
1. Provide sufficient torque to raise and lower mixer.
2. 120-volt, single-phase service.

2.07 SHOP PAINTING
A. Clean and shop prime all non-galvanized, non-stainless steel metal surfaces in accordance with Section 09900.

PART 3 EXECUTION
3.01 INSTALLATION
A. Install the mixer and appurtenances in accordance with the manufacturer’s instructions and in accordance with the Contract Documents.
   1. Set anchor bolts following manufacturer’s recommendations.
   2. Provide all lubricants required for initial operation.
B. Adjust the mixer to provide satisfactory operation.

3.02 FIELD PAINTING
A. Field-prepare and paint required surfaces as specified in Section 09900. Repair coatings damaged during shipment, storage, or installation.

3.03 FIELD QUALITY CONTROL AND TESTING
A. Perform field inspection and testing in accordance with Sections 01650.

3.04 MANUFACTURER’S FIELD SERVICES
A. Provide manufacturer’s field services in accordance with Sections SP-18.
B. Training
   1. Provide 8 hours of training to instruct Owner.

END OF SECTION
SECTION 11600
SUCTION LIFT PUMP STATIONS

PART 1 GENERAL

1.01 DESCRIPTION
A. Provide two factory-built, aboveground, fiberglass-reinforced pump stations, one each for the Recycle Pump Station and the Residuals Clarifier Feed Pump Station, as shown on Contract Documents.
B. Each station shall be complete with all equipment and accessories, but not limited to the following:
   1. Two self-priming, horizontal, motor-driven centrifugal pumps
   2. Valves and piping
   3. Drive units
   4. Control systems and wiring

1.02 QUALITY ASSURANCE
A. Comply with applicable portions of General Provisions and Section 15050.
B. Include a list of twenty-five installations operating over the last ten years provided by the manufacturer.
C. Provide components that are the standard product of a manufacturer regularly engaged in the production of the required materials and equipment.
D. Provide suction-lift pump stations and appurtenances from a single manufacturer.
E. Manufacturer shall be responsible for the design, construction, and proper operation of all components.
F. Manufacturer shall assemble and test all components before shipment.
G. Manufacturer shall ensure satisfactory performance under the specified operating conditions.
H. Manufacturer shall design pump stations for continuous-duty operation.
I. Comply with applicable standards including, but not limited to the most recent edition of the following:
   1. Hydraulic Institute (HI).

1.03 SUBMITTALS
A. Comply with Section SP-09.
B. Submit shop drawings and product data for all system components demonstrating compliance with Specifications, including:
   1. Make, model, and weight of each equipment assembly.
   2. Manufacturer’s catalog information, descriptive literature, specifications, and a complete bill of materials including identification of materials of construction.
3. Certified structural, mechanical, electrical, and erection drawings showing important details of construction, equipment dimensions, size, anchor bolt locations, and locations of connections to other work.

4. Certified pump performance curves showing flow, head, efficiency and BHP over the manufacturer’s recommended operating range.

5. Lubrication requirements.

6. Certified NPSH curve based on previous shop test data from similar pumps or actual test data of project pumps.

7. Motor data. Identify
   a. Nominal rated horsepower.
   b. Rated ambient temperature.
   c. Service factor.
   d. Power requirements.
   e. Required full load current at rated horsepower.
   f. Starting code letter.
   g. Locked rotor KVA and current.

8. Special shipping, storage and protection, and handling instructions.

9. A list of manufacturer’s recommended parts required to maintain the equipment for a period of one year, with current price information.

10. A list of special tools, materials, and supplies furnished with the equipment for use prior to and during startup, and for future maintenance.

11. Manufacturer’s installation instructions.

C. Submit compliance certificates for specified tests.

D. Submit manufacturers’ certificates in accordance with Section SP-08.

E. Submit operation and maintenance manuals in accordance with Section SP-10.

F. Submit list of required spare parts for the system. Furnish the following spare parts, minimum:
   1. Four spare parts kits, each including one mechanical cartridge seal, one set of rotating assembly adjustment shims, one cover plate O-ring, one rotating assembly O-ring
   2. One complete rotating assembly
   3. Four suction flap valve assemblies
   4. One belt tensioning gauges - spring loaded
   5. Four quarts of seal lubricant
   6. Four air pump repair kits for bubbler level control system
   7. Four discharge check valve springs
   8. One complete Air Mate® air release valve
   9. VFD – refer to Specification Section 16157

1.04 PRODUCT DELIVERY, STORAGE, AND HANDLING

A. Deliver, handle, and store the equipment in accordance with Section SP-14.
B. Comply with American National Standards Institute/Hydraulic Institute (ANSI/HI) 2.4

1. Covered, dry and ventilated storage may be used if stored on site for less than 60 calendar days.

2. Storage on site for longer than 60 days shall require the manufacturer to prepare the equipment for long term storage prior to shipment.
   a. Frequency of rotation shall be as recommended by the manufacturer.
   b. Maintain log indicating time of rotation. Log shall be initialed by the Engineer.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Gorman-Rupp Company

B. Goulds

C. Or equal

2.02 STATION ENCLOSURE

A. Description:
   1. Dimensions of the enclosure shall be approximately 8-feet by 12-feet and 6-feet-high.
   2. The enclosure shall consist of a base to support the pumps and a cover that can be moved without lifting.
   3. The station enclosure shall provide sufficient inside area for maintenance personnel to perform normal operation and maintenance inside, sheltered, and free from foul weather.

B. Materials:
   1. Use molded, fiberglass reinforced-orthophthalic-polyester resins, with a minimum of 30 percent fiberglass, and a maximum of 70 percent resin. Glass fibers shall have a minimum average length of 1-¼-inch. Resin fillers or extenders shall not be used.
   2. Materials shall be impervious to micro-organisms, mildew, mold, fungus, corrosive liquids, and gases.
   3. All interior surfaces of the housing shall be gel-coated with a polyester resin to provide:
      a. Maintenance-free service
      b. Abrasion resistance
      c. Protection from sewage, greases, oils, gasoline, and other common chemicals.
      d. Color fastness
      e. Gloss retention
   4. Interior surfaces of the enclosure cover and end panels shall be white for maximum light reflectivity.
   5. The outside of the enclosure shall be coated with a suitable pigmented resin compound to ensure long, maintenance-free life. The fiberglass enclosure shall be a standard product of the pump station manufacturer.
C. Enclosure Base:

1. Steel Frame:
   a. Constructed with a completely encapsulated structural steel frame for corrosion protection.
   b. Frame shall provide adequate structural support for pumps, motors, and piping.
   c. The encapsulated frame shall extend to lift points provided and assure adequate strength to resist deformation of structure during shipping, lifting, or handling.
   d. The structural steel base shall be completely encapsulated within a molded fiberglass reinforced polyester base shell.
   e. Wall thickness shall be a minimum of 3/16-inch and base height a minimum of 5-inches to provide natural drainage of pump station floor to concrete pad.

2. Interior of base shall be filled with a formed-in-place, rigid polyurethane structural foam. Foam shall be of closed-cell type with a minimum density of 2.5 pounds per cubic feet.

3. Holes through the base shall be provided for suction and discharge lines and air release lines.

4. Holes for the suction and discharge lines shall be provided with a grout dam incorporated in a grout-retention cavity that can be filled with grout to seal each pipe-to-base joint.

5. Station base shall incorporate a suitable flange designed for securing the pump station to the concrete pad.

D. Enclosure:

1. Cover:
   a. The enclosure cover shall be movable, without lifting, to permit overhead access to either half of the station interior, and shall be completely removable.
   b. A hasp-and-staple locking device shall be provided to secure the enclosure over the station base.
   c. Suitable gasketing shall be provided between the enclosure cover and end panels and base for protection from the elements.
   d. The enclosure cover shall be provided with a hinged fiberglass-reinforced access door. Minimum dimensions of the door shall be 27-inches wide by 56-inches high.

2. Door:
   a. The door shall be a minimum 5/8-inch-thick and shall be hinged with a full-length stainless-steel piano hinge to a full-perimeter, aluminum door casing secured to the enclosure cover.
   b. Door casing shall incorporate a suitable drip shield over the opening.
   c. Door shall be furnished with a locking handle connected to a three-point latching mechanism.
   d. Latch shall engage door casing at top, side, and bottom.
e. All mounting hardware for door casing and door shall be concealed, or of such type as to prevent vandalism with ordinary tools.

E. Receptacle:
1. A duplex ground-fault-indicating utility receptacle shall be mounted inside the pump station
2. Receptacle shall provide 115-volt, single-phase, 60-hertz, power.
3. Receptacle shall be NEMA 5-15r configuration, heavy-duty, specification grade and fitted with a weatherproof cover.
4. The receptacle shall be protected by normal-duty circuit breaker.

F. Exhaust Fan:
1. A shuttered exhaust fan with a minimum capacity of 500 cubic feet per min (cfm) to change the air in the enclosure once every minute shall be mounted in one end wall.
2. Air intake shall be mounted in the wall approximately opposite to this end panel.
3. Both intake and exhaust opening shall be equipped with a screen and cowl, suitably designed to prevent the entrance of rain, snow, rocks, and other foreign material.
4. The fan circuit shall be protected by a normal-duty circuit breaker.

G. Station Light:
1. An enclosed and gasketed 200-watt light fixture shall be provided. The fixture shall be vapor-tight, universal type. The fixture shall be centrally located to provide adequate light to all parts of the station and shall not constitute a physical hazard to inspection or service personnel.
2. The light circuit shall be protected by a normal-duty circuit breaker and shall be provided with a disconnect switch.

H. Station Heater:
1. Pump station shall be provided with a 1,300/1,500-watt, 115-volt electric heater with cord and grounding plug. Ungrounded heaters shall not be acceptable.

I. Low Temperature Thermostat:
1. Each enclosure shall be provided with a thermostat to serve as a low-temperature alarm.

2.03 PUMPS

A. Pump Description:
1. Pumps shall be Gorman-Rupp Model T6A3S-B horizontal, self-priming centrifugal type.
2. All openings, internal passages, and internal recirculation ports shall be large enough to permit the passage of the specified spherical solids passing capability
3. Screens or any internal devices that create a maintenance nuisance or interfere with priming and performance of the pump shall not be permitted.
4. The pumps shall have the following characteristics:

<table>
<thead>
<tr>
<th>Design Characteristics</th>
<th>Recycle Pump Station</th>
<th>Residuals Clarifier Feed Pump Station</th>
</tr>
</thead>
<tbody>
<tr>
<td>Suction connection, flanged (inches)</td>
<td>6</td>
<td>6</td>
</tr>
<tr>
<td>Discharge connection, flanged (inches)</td>
<td>6</td>
<td>6</td>
</tr>
<tr>
<td>Minimum shutoff head, each pump (feet)</td>
<td>78</td>
<td>54</td>
</tr>
<tr>
<td>Pump speed (rotations per minute (rpm))</td>
<td>1,240</td>
<td>1,030</td>
</tr>
<tr>
<td>Maximum NPSH required at design point (feet)</td>
<td>9</td>
<td>9</td>
</tr>
<tr>
<td>Minimum reprime lift capability (feet)</td>
<td>21</td>
<td>16</td>
</tr>
<tr>
<td>Spherical solids passing capability (inches)</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Motor horsepower</td>
<td>25</td>
<td>15</td>
</tr>
<tr>
<td>Motor speed (rpm)</td>
<td>1,750</td>
<td>1,750</td>
</tr>
<tr>
<td>Impeller diameter (inches)</td>
<td>12-3/8</td>
<td>12-3/8</td>
</tr>
</tbody>
</table>

B. Pump Performance:

1. Each pump must have the necessary characteristics and be properly selected to perform under these operating conditions:

<table>
<thead>
<tr>
<th>Performance Characteristics</th>
<th>Recycle Pump Station</th>
<th>Residuals Clarifier Feed Pump Station</th>
</tr>
</thead>
<tbody>
<tr>
<td>Capacity (gpm)</td>
<td>900</td>
<td>900</td>
</tr>
<tr>
<td>Total dynamic head (feet)</td>
<td>50</td>
<td>30 (maximum)</td>
</tr>
<tr>
<td>Total dynamic suction lift (feet)</td>
<td>12 (maximum)</td>
<td>12 (maximum)</td>
</tr>
<tr>
<td>Maximum static suction lift (feet)</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>Static discharge head (feet)</td>
<td>30</td>
<td>Varies</td>
</tr>
</tbody>
</table>

2. Each pump shall be so designed as to retain adequate liquid in the pump casing to insure unattended automatic repriming while operating at its rated speed in a completely open system without suction check valves and with a dry suction leg.

C. Reprime Performance:

1. Each pump must be capable of the specified reprime lift while operating at the selected speed and impeller diameter.
2. Systems requiring ancillary vacuum generating devices shall not be acceptable. Additional standards under which reprime tests shall be run are:
   a. Piping shall incorporate a discharge check valve downstream from the pump. Check valve size shall be equal (or greater than) the pump discharge diameter.
   b. A ten-foot length of one-inch pipe shall be installed between pump and discharge check valve. This line shall be open to atmosphere at all times to duplicate the air displacement rate of a typical pump station fitted with an air release valve.
   c. No restrictions shall be present in pump or suction piping that could serve to restrict the rate of siphon drop of the suction leg.
   d. The pipe size used for the reprime performance test shall be the same size as the pump suction diameter.
   e. Impeller shall be set at the clearances recommended by the manufacturer in the pump service manual.
   f. Reprime lift repeatability shall be demonstrated by five sequential reprime cycles.
   g. Liquid to be used for reprime test shall be water.

D. Serviceability:

1. The pump manufacturer shall incorporate the following features:
   a. No special tools shall be required for replacement of any components within the pump. Threaded fasteners shall be of the Unified National Standard type.
   b. The mechanical seal shall be a one-piece cartridge type to allow for easy replacement. Mechanical seals requiring assembly of individual components shall not be acceptable.
   c. The pump must be equipped with a removable cover plate, allowing access for service and repair without removing suction or discharge piping.
   d. The pump shall be fitted with a replaceable wear plate. Replacement of the wear plate, impeller, seal, and suction check valve shall be accomplished through the removable cover plate without removing suction or discharge piping.
   e. The entire rotating assembly, which includes bearings, shaft, seal, and impeller, shall be removable as a unit without removing the pump volute or piping.
   f. Each pump shall incorporate a suction flap valve that can be removed or installed through the removable cover plate opening, without disturbing the suction piping. Sole function of the suction flap valve shall be to eliminate re-priming with each cycle. Pumps requiring suction flap valves to prime or reprime will not be acceptable.
   g. Atmospheric isolation: The shaft bearings shall be isolated from the seal cavity with an air gap to provide positive protection of the bearings in the event of a seal leak and to provide for external monitoring of the seal integrity.
   h. Adjustment of the impeller face clearance (distance between impeller and wear plate) shall be accomplished by external means.
The adjusting mechanism shall provide a means to make discrete calibrated movements in increments of 0.005 inches.

No special tools, measuring devices, feeler gauges, or other tools shall be required to make these impeller-to-wear plate clearance adjustments.

Clearances shall be maintained by a 4-point external shimless coverplate adjustment system with four collar and adjusting screws. Provide 4-point incremental clearance adjustment.

Each of the 4 points shall be lockable to prevent inadvertent clearance increases or decreases due to equipment vibration.

The 4-point system shall provide equal clearance gaps at all points between the impeller and wear plate.

Systems that require realignment of belts, couplings, or sheaves shall not be acceptable. Coverplate shall be capable of being removed and reinstalled without disturbing the clearance settings.

Clearance adjustment systems that utilize less than 4-point system will not be considered.

There shall be provisions for additional clearance adjustment in the event that adjustment tolerances have been depleted from the coverplate side of the pump. The removal of stainless steel shims from the rotating assembly side of the pump shall allow for further adjustment as described above.

Clearance adjustment which requires movement of the shaft only, thereby adversely affecting seal working length or impeller back clearance, shall not be acceptable.

Construction:

1. Pump casing: Class 30 gray iron, foot-supported, with horizontal centerline suction and vertical discharge.
   a. The casing shall have a top-mounted, 3-1/2-inch priming fill port with a safety lock bar cover.
   b. Hand nut threads shall provide slow release of pressure, and the clamp bar shall be retained by detent lugs.
   c. A Teflon gasket shall prevent adhesion of the fill port cover to the casing.
   d. Casing shall have no openings of smaller diameter than the specified sphere size.
   e. Casing shall be designed to retain sufficient liquid to ensure automatic repriming and unattended operation.
   f. A minimum 1-1/4-inch-diameter drain hole shall be provided for attachment of the pump drain kit.
   g. Bolts and other threaded fasteners shall have Unified National Standard threads.
   h. Suction flap valve:
      1. Molded neoprene with integral steel and nylon reinforcement.
(2) A blow-out center shall protect the pump casing from hydraulic shock or excessive pressure.

(3) Removal or installation of the check valve must be accomplished through the cover plate opening without disturbing the suction piping.

(4) Sole function of the suction flap valve shall be to save energy by eliminating need to re-prime after each pumping cycle.

(5) Pumps requiring a suction check valve to assist re-prime will not be acceptable.

2. Cover plate: Cover plate shall be Class 30 cast iron.
   a. Retained by four hand nuts for complete access to pump interior.
   b. Cover plate removal must provide ample clearance for removal of stoppages, and allow removal or service to the impeller, seal, wear plate or suction flap valve.
   c. Replaceable wear plate:
      (1) Secured to the cover plate by four welded studs and nuts. The wear plate shall be cast in AISI 1026 Carbon Steel.
      (2) The wear plate shall be of sufficient width to maintain the manufacturer’s recommended clearance between the entire edge of each impeller vane and the wear plate.
      (3) Wear plate attachment hardware shall have Unified National Standard threads and shall be located out of the direct flow path of the liquid into the impeller.
   d. O-ring Seals:
      (1) Two Buna-N o-rings shall seal cover plate to the pump casing.
      (2) The inner cover plate o-rings shall provide a seal between the suction chamber and the discharge chamber of the pump casing to eliminate the possibility of recirculation at the wear plate.
   e. A pressure-relief valve shall be supplied in the cover plate. Relief valve shall open at 75 psi.
   f. Pusher bolt capability to assist in removal of coverplate. Threaded pusher bolt holes shall be sized to accept same retaining capscrews as used in rotating assembly.
   g. Easy-grip handle shall be mounted to face of coverplate.

3. Rotating assembly:
   a. Impeller: Two-vaned, semi-open, non-clog, 65-45-12 ductile iron, with integral pump-out vanes on the back shroud. Impeller shall thread onto the pump shaft and be secured with a lock screw.
   b. Shaft: Shaft shall be constructed of 4150 alloy steel and shall employ 4130 alloy steel shaft sleeve.
   c. Mechanical seal: A mechanical cartridge seal shall seal the pump shaft against leakage. The stationary sealing member and the mated rotating face shall be tungsten titanium carbide. Each of the mated surfaces shall be lapped to a flatness of three light bands (35 millionths of an inch), as measured by an optical flat under monochromatic light. The
stationary seal seat shall be double floating so that faces will not lose alignment during periods of shock loads that will cause deflection, vibration, and axial movement of the pump shaft. The seal shall be warranted for five years from date of shipment.

d. Lubrication: Separate oil filled cavities, vented to atmosphere, shall be provided for shaft seal and bearings. Oil cavities must be cooled by the liquid pumped. Three lip seals will prevent leakage of oil.

(1) The bearing cavity shall have an oil level sight gauge and fill plug with check valve. The clear sight gauge shall provide easy monitoring of the bearing cavity oil level and condition of oil without removal of the fill plug. The check valve shall vent the cavity but prevent introduction of moist air to the bearings.

(2) The seal cavity shall have an oil level sight gauge and fill plug with vent. The clear sight gauge shall provide easy monitoring of the seal cavity oil level and condition of oil without removal of the vented fill plug.

(3) Double lip seal shall provide an atmospheric path providing positive protection of bearings, with capability for external drainage monitoring.

e. Atmospheric isolation: The shaft bearings shall be isolated from the seal cavity with an air gap to provide positive protection of the bearings in the event of a seal leak and to provide for external monitoring of the seal integrity.

f. Seal plate: Replaceable seal plate shall be constructed of Class 30 gray and shall be bolted to the bearing housing.

g. Shaft bearings: Shall be anti-friction ball or tapered roller bearings, of ample size and proper design to withstand all radial and thrust loads which can reasonably be expected during normal operation.

h. Pusher bolt capability to assist in removal of rotating assembly. Pusher bolt threaded holes shall be sized to accept same capscrews as used for retaining rotating assembly.

4. Suction and discharge spools: Each pump shall be equipped with one-piece, cast iron spools, flanged on each end. Each spool shall have one, 1-1/4-inch-National pipe thread (NPT) and one, 1/4-inch-NPT tapped hole with pipe plugs for mounting of gauges or other instrumentation.

2.04 PUMP ACCESSORIES

A. Gauge Kit With Vibration Isolation Frame:

1. Each pump shall be equipped with a glycerin-filled compound gauge to monitor suction pressures, and a glycerin-filled pressure gauge to monitor discharge pressures.

2. Gauges shall be a minimum of 4-inches in diameter, and shall be graduated in feet water column. Rated accuracy shall be 1 percent of full-scale reading.

3. Compound gauges shall be graduated -34 feet to +34 feet water column minimum. Pressure gauges shall be graduated 0 to 140 feet water column, minimum.

4. Gauges shall be mounted on a vibration isolation frame assembly with resilient panel, frame, and adjustable brackets which shall be firmly secured to pumps or piping.
5. Gauge installations shall be complete with all hoses and fittings, and shall include a shutoff valve installed in each gauge inlet at the point of connection to suction and discharge pipes.

6. Gauge kit shall be supplied with stainless steel fittings.

B. Pump Drain Kit:

1. The pump drain kit shall consist of a 10-feet long plastic hose with a quick connect female Kamlock fitting on one end of hose and two sets of fittings for pump drains. Each set of fittings for pump drain includes a pipe nipple, bushing, bronze gate valve and quick connect male Kamlock fitting.

2. Pump drain kit shall be supplied with stainless steel fittings.

2.05 VALVES AND PIPING

A. Check Valves, 8-inch:

1. Each pump shall be equipped with a full flow type check valve, capable of passing a 3-inch spherical solid, with flanged ends and be fitted with an external lever and spring.

2. 316 stainless steel body ring shall be threaded into the valve port.

3. Valve clapper shall be cast iron, rubber face, and shall swing completely clear of waterway when valve is full open. Hinge pin shall be of 18-8 stainless steel construction and shall be utilized with bronze bushings and packing type seal.

4. Valves shall be equipped with removable cover plate to permit entry or for complete removal of internal components without removing the valve from the line.

5. Valve shall be rated at 175-pounds per square inch (psi) water working pressure, 350-psi hydrostatic test pressure. Valves other than full-flow-type, or valves mounted in such a manner that prevents the passage of a 3-inch spherical solid, shall not be acceptable.

B. Plug Valve, 8-inch:

1. A 3-way plug valve must allow either or both pumps to be isolated from the force main.

2. The plug valve shall be non-lubricated, tapered type.

3. Valve body shall be semi-steel with flanged end connections drilled to 125-pound standard. The drip-tight shutoff plug shall be mounted in stainless steel bearings and shall have a resilient facing bonded to the sealing surface.

4. Valve shall be operated with a single lever actuator providing lift, turn, and reseat action. The lever shall have a locking device to hold the plug in the desired position.

C. Air Release Valves (High-Impact Composite Polyester):

1. Each pump shall be equipped with an Air Mate® automatic air release valve to vent air to atmosphere during initial priming or unattended repriming cycles.

2. The valve shall automatically close operating solely on discharge pressure to prevent recirculation. A visible indication of valve closure shall be evident.

3. Air release valve piping must discharge directly into wet well. ARV piping shall not discharge to a sump.
4. The air release valve shall be constructed of high-impact composite polyester containing not less than 30 percent glass filler.

5. The valve body shall incorporate an internal passageway that allows all debris to pass through the valve chamber between operational cycles. The diaphragms shall be Buna-N, Fluorocarbon or ethylene propylene diene monomer (EPDM), with a polyester mesh rated for 250 psi of pressure.

6. The vertical plunger shall be constructed of Acetal and polytetrafluoro ethylene (PTFE) fluorocarbon filler. The independent, dual diaphragms and single, vertical valve plunger shall incorporate a media fluid that passes through an orifice and separates the actions of each.

7. The valve shall employ an externally-adjustable restrictor for applications below four feet of static discharge head.

8. The valve body shall incorporate passageways having minimal constrictions and no directional course changes integral to the body of the valve. The inlet shall be 1 inch NPT female and the discharge outlet shall be 1-1/4-inch-NPT female. The valve shall be mounted horizontally, at 90 degrees to the vertical plunger.

9. The valve shall be capable of operation on applications ranging from four to 400 feet of water column without the need for adjustment or change of springs or other parts.

10. Air release valves shall be connected to pump station piping using stainless steel pipe fittings.

11. Each air release valve shall be provided with an isolation ball valve.

D. Piping:

1. Flanged header pipe shall be centrifugally cast, 8-inch ductile iron, complying with ANSI/AWWA A21.51/C115 and Class 53 thickness flanges shall be cast iron Class 125 and comply with ANSI B16.1 all piping pipe and flanges shall be threaded and suitable thread sealant applied before assembling flange to pipe.

2. Bolt holes shall be in angular alignment within ½-degree between flanges. Flanges shall be faced and a gasket finish applied that shall have concentric grooves a minimum of 0.01 inch deep by approximately 0.03-inch wide, with a minimum of three grooves on any given surface spaced a maximum of ¼-inch apart.

E. Supports and Thrust Blocks:

1. Contractor must ensure all pipes connected to the pump station are supported to prevent piping loads from being transmitted to pumps or station piping.

F. Gauge Connection Assembly:

1. The header piping shall be equipped with a gauge connection assembly located between the discharge check valve and force main isolation plug valve allowing the operator to easily attach a discharge gauge on any pump for troubleshooting.

2. The gauge assembly shall consist of a ¼-inch brass pipe nipple, ¼-inch brass full port ball valve and a quick-connect fitting.

3. The gauge connection assembly shall be installed in the discharge header piping such that the static and dynamic pressure in the force main can be read at all times unless the force main isolation plug valve is closed for that particular pump.
2.06 DRIVE UNIT

A. Motors:
   1. The pump motors shall be horizontal, totally enclosed fan cooled, induction type, with normal starting torque and low starting current characteristics. The motors shall not be overloaded at the design condition or at any head in the operating range as specified.
   2. Provide premium efficiency type motors.
   3. Motors shall be tested in accordance with provisions of ANSI/IEEE 112.
   4. Each motor shall be in current NEMA design B cast iron frame with copper windings.
   5. Motors shall be inverter rated for use with a variable-frequency drive.

B. Drive Transmission:
   1. Power shall be transmitted from motor to pump by means of v-belt drive assembly. The drive assembly must be selected to establish proper pump speed to meet the specified operating conditions.
   2. Each drive assembly shall have a minimum of two v-belts. In no case will a single belt drive be acceptable. Each v-belt drive assembly shall be selected on the basis that adequate power will be transmitted from driver to pump. Drive systems with a safety factor of less than 1.5 shall not be considered sufficient for the service intended. Computation of safety factors shall be based on performance data published by the drive manufacturer.
   3. V-belts shall be the banded type.

C. Belt Guards:
   1. Pump drive transmissions shall be enclosed on all sides in a guard constructed of any one or combination of materials consisting of expanded, perforated, or solid sheet metal, except that maximum perforated or expanded openings shall not exceed ½ inch.
   2. Guards shall be manufactured to permit complete removal from the pump unit without interference with any unit component, and shall be securely fastened to the unit base.
   3. All metal shall be free of burrs and sharp edges. Structural joints shall be continuously welded. Panels may be riveted to frames with not more than five-inch spacing. Tack welds shall not exceed four-inch spacing.

2.07 FINISH

A. Comply to applicable parts of Section 09900

B. Surface Preparation:
   1. Pumps, piping and exposed steel framework shall be prepared utilizing a six-stage surface preparation system including the application of iron phosphate and sealer/rust inhibitor.
   2. The method shall provide excellent removal of substrate contaminants and very effectively etch pores in the metal resulting in a superior adhesion of primer and paint.
   3. Surface preparation shall be in accordance with Military handbook- MIL-T-704J. Sandblasting shall not be acceptable.
C. Paint:
1. Paint shall be low VOC, alkyd based, high solids, semi-gloss white enamel for optimum illumination enhancement and incorporate rust inhibitive additives.
2. The finish coat shall be 1.0 to 1.5 mil dry film thickness (minimum), resistant to oil mist exposure, solvent contact and salt spray.
3. The factory finish shall allow for over-coating and touch up after final installation.
4. All flanged connections including pumps, valves, piping and fittings shall be painted prior to assembly.

2.08 PUMP CONTROL SYSTEM
A. General:
1. This specification covers a pump control system for the duplex pumping station including motor circuit breakers, variable frequency drives, full voltage bypass motor starters, pump motor overload protection, door mounted operator controls, and liquid level controls.
2. The liquid level control will include an air bubbler level control system, electronic pressure switch, pump sequence control, alarms and pump safety shutdowns.
3. Refer to Specification Section 16155 for motor starters.

B. UL Listing:
1. The pump controls shall be manufactured by the pump manufacturer who shall be a UL panel builder and each assembly shall bear a serialized UL label listed for “Enclosed Industrial Control Panels.”
2. The enclosure and all components mounted on the sub-panel or control cover shall conform to UL descriptions and procedures. Listing for open style industrial control panels or an assembly of listed or recognized components shall not be acceptable.

C. Panel Enclosure:
1. Enclosure shall be constructed in conformance with applicable section of National Electrical Manufacturers’ Association (NEMA) standards.
2. Refer to Specification Section 16946 for Control Panel requirements.

D. Motor Branch Components:
1. All motor branch components shall be of the highest industrial quality. Operating coils of all AC control devices shall be rated for 120 volts, and shall be suitable for use in a voltage range of 108 to 132 volts, 60 hertz.

E. Circuit Breakers and Operating Mechanisms:
1. A properly sized heavy duty air circuit breaker shall be furnished for each pump motor, and shall have a symmetrical RMS interrupting rating of 42kAmps at 480 volts (to be determined by the power company and/or electrical engineer prior to bid). All circuit breakers shall be sealed by the manufacturer after calibration to prevent tampering.
2. A padlocking operating mechanism shall be installed on each motor circuit breaker. Operator handles for the mechanisms shall be located on the exterior of the control compartment door, with interlocks which permit the door to be opened only when circuit breakers are in the “off” position.

F. Variable Frequency Drives:
1. Each pump motor shall be furnished with a variable frequency drive (VFD) mounted within the pump control panel enclosure.

2. The inverter shall be suitable for operation of NEMA Design B, 4 pole motors. Refer to Specification Section 16157 for VFD requirements.

3. Auto restart shall occur when the inverter faults. Auto restart shall be adjustable up to 9 attempts with 0.5 to 30 second intervals. Auto restart will not be attempted for ground fault, output shorted, transistor shorted or internal microprocessor fault but will trip out immediately, activate the fault relay and make the appropriate indication on the display.

G. Indicators:
1. Indicating lights will be furnished for the following functions:
   a. Pump No. 1 run
   b. Pump No. 2 run
   c. High wet well level alarm (bubbler)
   d. Alarm silenced
   e. Pump No.1 bypass active
   f. Pump No. 2 bypass active

H. Switch Controls:
1. A normal duty thermal-magnetic circuit breaker shall protect all control circuits by interrupting control power.

2. Pump mode selector switches shall be connected to permit manual start and manual stop of each pump individually or permit automatic operation under control of the liquid level control system. Manual operation shall override shutdown systems except motor overload and phase failure relays.

3. Pump sequence selector switch shall permit selection of automatic pump alternation, or selection of either pump to run as lead pump for each cycle. Pump alternator relay shall be electro-mechanical industrial design. Override switches shall be connected to bypass the level control system and all shutdown systems supplied with it, to provide manual start and manual stop of each pump individually in the event of level control system malfunction.

4. A selector switch shall provide manual alternation of the pumps. The switch shall be connected in such a manner that either pump may be selected to operate continuously.

5. A pushbutton switch shall be provided to silence the 115-volt AC alarm circuits while corrective actions are underway. Depressing the alarm silence pushbutton shall also cause the high water alarm circuit to reset when the liquid level has been lowered.

I. High Pump Temperature Shutdown:
1. The control panel shall be equipped with circuitry to override the level control system and shut down the pump motor(s) when required to protect the pump from damage caused by excessive temperature.

2. A thermostat shall be mounted on each pump to detect its temperature. If the pump temperature should rise to a level that could cause pump damage, the thermostat shall cause the pump motor to shut down. A visual mechanical indicator shall indicate that the pump motor has been stopped because of a high temperature condition.
3. The pump shall remain locked out until the pump has cooled and the circuit has been manually reset. Automatic reset of such a circuit shall not be acceptable.

J. Elapsed Time Meters:
1. Elapsed time meters (non-reset-type) shall be connected to each VFD and motor starter to indicate the total running time of each pump in “hours” and “tenths of hours”.

K. Pump Start Delay:
1. The lag pump will be equipped with a fixed five-second time delay to prevent simultaneous motor starts.

L. IO Signals for customer use:
1. Provide separate contacts for the following alarm/status conditions:
   a. Pump run, #1 – normally open
   b. Pump run, #2 – normally open
   c. Station low temperature – normally closed
   d. Drive failure, #1 – normally open
   e. Drive failure, #2 – normally open
   f. Pump bypass enabled, #1 – normally open
   g. Pump bypass enabled, #2 – normally open
   h. High pump temperature, #1 – normally open
   i. High pump temperature, #2 – normally open

2. Provide a 4-20 mA output for wet well level monitoring signal.

M. Secondary Surge Arrestor:
1. The control panel shall be equipped with a surge arrestor to minimize damage to the pump motors and control from transient voltage surges. The arrestor shall utilize metal-oxide varistors encapsulated in a non-conductive housing. The arrestor shall have a current rating of 60,000 Amps and a Joule rating of 1,500.

N. Receptacle:
1. A duplex ground fault interrupter utility receptacle providing 115 VAC, 60 hertz, single-phase current shall be provided. Receptacle circuit shall be protected by a 15-ampere thermal-magnetic circuit breaker.

O. Auxiliary Power Transformer:
1. The control panel shall be equipped with a 3 KVA step-down transformer to supply 115 volt, AC, single phase for the control and auxiliary circuits. The primary side of the transformer shall be protected by a thermal-magnetic air circuit breaker, specifically sized to meet the power requirements of the transformer. A mechanical operating mechanism shall be installed on the circuit breaker to provide a means of disconnecting power to the transformer.

2. The padlockable operator handle for the operating mechanism shall be located on the exterior of the control panel with interlocks which prevent opening the door until primary circuit breaker is in the “OFF” position.
2.09 WIRING

A. General:
   1. The pump control as furnished by the manufacturer shall be completely wired except for the power feeder lines to the branch circuit breakers and final connections to remote alarm devices and between control assemblies.
   2. All wiring, workmanship, and schematic wiring diagrams shall be in compliance with applicable standards and specifications set forth by the National Electric Code (NEC).
   3. Refer to Section 16120 and 16946 for wiring requirements.

B. Wire Bundles:
   1. Control conductors connecting components mounted on the enclosure door shall be bundled and tied in accordance with good commercial practice. Bundles shall be made flexible at the hinged side of the enclosure. Adequate length and flex shall be allowed so that the door can swing to its full open position without undue mechanical stress or abrasion on the conductors or insulation. Bundles shall be clamped and held in place with mechanical fastening devices on each side of the hinge.

C. Conduit:
   1. All conduit and fittings shall be UL listed.
   2. Conduit shall be sized according to the National Electric Code.
   3. Refer to Specification Section 16110 for conduit requirements, raceways, boxes and fittings.

D. Grounding:
   1. The pump station manufacturer shall ground all electrical equipment to the closure back panel. The mounting surface of all ground connections shall have any paint removed before making final connections.
   2. The contractor shall provide an earth driven ground connection to the control panel at the main ground lug in accordance with the National Electric Code (NEC).

2.10 LEVEL CONTROL SYSTEM

A. Liquid Level Control:
   1. The manufacturer of the liquid level control system must be ISO 9001:2000 revision certified, with scope of registration including design control and service after sales activities.
   2. The level control system shall start and stop the pump motors in response to changes in wet well level, as set forth herein.
   3. The level control system shall be an ultrasonic transmitter manufactured by Hach or equal type system.
   4. The level control system shall incorporate automatic alternation to select first one pump, then the second pump, to run as lead pump for a pumping cycle. Alternation shall occur at the end of a pumping cycle.
   5. The level control system shall continuously monitor the wet well level, permitting the operator to read wet well level at any time. Upon operator selection of automatic operation, the level system shall start the motor for one pump when the liquid level in the wet well rises to the "lead pump start level". When the
liquid is lowered to the "lead pump stop level", the level system shall stop this pump. These actions shall constitute one pumping cycle. Should the wet well level continue to rise, the level system shall start the second pump when the liquid reaches the "lag pump start level" so that both pumps are operating. These levels shall be adjustable as described below.

a. The level system shall include integral components to compare the continuously level measurement with the different level set-point for lead, lag pump operation. Comparators shall be solid state, and shall be integrated with other components to perform as described below.

b. The level system shall consist of the following integral components: ultrasonic level transmitter, display, electronic comparators and output relays. A set of float switch shall be provided as a backup system.

(1) The level system shall incorporate a digital back lighted LCD panel display which shall indicate liquid level in the wet well, and the preset start and stop level for both lead and lag pump. The display shall be calibrated to read out directly in feet of water, with a full-scale indication of not less than 12 feet.

(2) Level adjustments shall be electronic comparator set points to control the levels at which the lead and lag pumps start and stop. Each of the level settings shall be easily adjustable and accessible to the operator without opening any cover panel. Controls shall be provided to permit the operator to read the selected levels on the display.

(3) If the ultrasonic level system (primary system) fails the pump shall be automatically controlled by a set of float switches.

c. Circuit design in which application of power to the lag pump motor starter is contingent upon completion of the lead pump circuit shall not be acceptable.

d. The electronic pressure switch shall be equipped with a simulator system capable of performing system cycle testing functions.

e. The level system shall be capable of controlling liquid levels in either a pump up or pump down application.

f. The level system shall be equipped with one (1) 4-20mA scalable output for connection to the Plant PLC.

g. The electronic pressure switch shall be equipped with an electronic comparator and solid state output relay to alert maintenance personnel to a high liquid level in the wet well. An indicator, visible on the front of the control panel, shall indicate that a high wet well level exists. The alarm signal shall be maintained until the wet well level has been lowered and the circuit has been manually reset. High water alarm shall be furnished with a dry contact wired to terminal blocks. A High Water alarm normally open contact shall be provided for Plant PLC High Level alarm.

(1) An alarm silence pushbutton and relay shall be provided to permit maintenance personnel to de-energize the audible alarm device while corrective actions are under way. After silencing the alarm device, manual reset of the alarm condition shall clear the alarm silence relay automatically.
PART 3 EXECUTION

3.01 SHOP TESTING
   A. Test each pump and driver in a test facility that has been approved by the Engineer. Perform the following in accordance with the latest edition of ANSI/HI 2.6:
      1. Hydrostatic Test
         a. Maintain hydrostatic test pressure for 5 minutes.
         b. Test all liquid containing components.
      2. Performance Test
         a. Conduct test on fully assembled pump and motor.
         b. Evaluate mechanical operation of each pump and motor.
            (1) Overheating
            (2) Cavitation
            (3) Excessive Vibration
            (4) Leakage
         c. May be witnessed by the Owner.
            (1) Provide Owner with 10 calendar day's written notice.
            (2) Owner will pay their own expenses to observe testing.
      d. Test at four operating speeds between the specified minimum and maximum values. Demonstrate compliance with the specified performance.
      e. Provide certified performance curve for each tested operating speed.
   B. Conduct each test in accordance with Hydraulic Institute Standards.
   C. Submit all test results to the Engineer. Test results must be approved by Engineer prior to shipping a pump and driver to the project site.

3.02 INSTALLATION
   A. Install all pumps and appurtenances in accordance with the manufacturer instructions, ANSI/HI 2.4, and the Contract Documents.
   B. The manufacturer shall supervise installation of all pumps and appurtenances.
   C. Install, level, and align pump station as indicated on project drawings.
   D. Suction pipe connections must be vacuum tight.
   E. Fasteners at all pipe connections must be tight.
   F. Install pipe with supports and thrust blocks to prevent strain and vibration on pump system piping.
   G. Install and secure all service lines (level control, air release valve or pump drain lines) as required in wet well.
   H. Check motor and control data plates for compatibility to site voltage. Install and test the electrical ground prior to connecting line voltage to pump control panel.
   I. After all anchor bolts, piping connections are installed, seal all openings between wet well and pump enclosure.
3.03 FIELD PAINTING
   A. Field-prepare and paint all shop primed pump surfaces as specified in Section 09900.

3.04 FIELD QUALITY CONTROL AND TESTING
   A. Perform field inspection and testing in accordance with Section 01650.
   B. Demonstrate compliance with all requirements of these specifications.
   C. Prior to start-up, clean wet well by removing construction debris and foreign material.

3.05 MANUFACTURER’S FIELD SERVICES
   A. Provide manufacturer’s field services in accordance with Section SP-18 and the following:
      1. Supervise the installation.
      2. Inspect equipment after installation.
         a. Provide engineer with a written inspection report.
         b. Issue manufacturer’s certificate of proper installation in accordance with Section SP-08 when equipment is ready to operate as designed.
   B. Training
      1. Provide two trips of 8 hours each to instruct representatives of the Owner and Engineer.

END OF SECTION
PART 1 GENERAL

1.01 DESCRIPTION
A. Provide all equipment and appurtenances in accordance with these specifications.
   1. Systems shall be furnished complete and ready to operate as specified and required.
   2. Provide all miscellaneous components required for operation, regardless of whether or not they are shown on the drawings or specified.
B. In case of conflict with the requirements of the individual specification sections, the individual specification sections shall govern.

1.02 QUALITY ASSURANCE
A. Provide components that are the standard product of a manufacturer regularly engaged in the production of the required materials and equipment.
   1. Provide the latest standard design that complies with all requirements of these specifications.
   2. A single manufacturer shall provide all components.
   3. The manufacturer shall be responsible for the design, construction and proper operation of all components.
   4. Items of the same type or class shall be provided by the same manufacturer, unless specified otherwise.
B. Comply with applicable standards including, but not limited to the most recent edition of the following:
   1. Underwriters Laboratories (UL).
   2. American Society of Mechanical Engineers (ASME).
   3. American Gear Manufacturer’s Association (AGMA).
   5. Air Movement and Control Association (AMCA).
   9. National Science Foundation (NSF)
10. Sheet Metal and Air Conditioning Contractors National Association.
C. Provide a label or listing indicating compliance with specified standards where possible prior to delivery to the project site.
D. Design to provide satisfactory performance under the specified operating conditions.
E. Use only certified welders and comply with the requirements of the American Welding Society (AWS) whenever welding is required.
F. Conform to AISC standards when fabricating structural or miscellaneous steel used with equipment.
1. Design structural members for the appropriate shock and vibratory loads.
2. Provide steel that is submerged or partially submerged at least ¼ inches thick.

1.03 SUBMITTALS

A. Comply with Section SP-09. Include the following information:
   1. Make, model, and weight of each major component including miscellaneous appurtenances.
   2. Manufacturer’s catalog information that describes each type of equipment provided. Include
      a. Specifications
      b. Performance
      c. Capacity
      d. Noise ratings
      e. A complete bill of materials that identifies all materials of construction.
      f. Control schematics and wiring diagrams
      g. Electrical data
         (1) Temperature rating
         (2) Power factor at full and ¾ load
         (3) Efficiency at full load and rated operating condition
         (4) Type of Bearings and Lubrication requirements
   3. Sizing calculations for each major component
      a. Demonstrate acceptable performance for specified operating conditions.
      b. Size each component and indicate the following:
         (1) Minimum force required to operate,
         (2) The force provided,
         (3) Full load and locked rotor current draw,
         (4) Rated horsepower.
   4. Certified structural, mechanical, electrical, and erection drawings. Prepare drawings to scale and show:
      a. Plan and sectional views.
      b. Piping and duct work, including supports.
      c. Important details of construction,
      d. Equipment dimensions,
      e. Size and location of anchor bolts, and
      f. Locations of connections to other work.
   5. Special shipping, storage, protection, and handling instructions.
   6. Cleaning, lubrication, and maintenance instructions during storage and prior to initial operation.
7. A list of manufacturer’s recommended parts required to maintain the equipment for a period of one year, with current price information.

8. A list of special tools, materials, and supplies furnished with the equipment for use prior to and during startup, and for future maintenance.

9. Manufacturer’s installation instructions.

10. Welding certificates indicating the type of welding that can be performed by each welder.

B. Submit compliance certificates for specified tests.

C. Submit Operation and Maintenance Manuals in accordance with Section SP-10.

1. A list of manufacturer’s recommended parts required to maintain the equipment for a period of one year, with current price information.

2. A list of special tools, materials, and supplies furnished with the equipment for use prior to and during startup, and for future maintenance.

3. Manufacturer’s installation instructions.

D. Submit manufacturer’s certificates in accordance with Section SP-08.

1.04 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Deliver, handle, and store the equipment in accordance with Section SP-14.

B. Box, crate or otherwise completely enclose all material and equipment such that it is protected during shipment, storage, and handling.

1. Clearly label with manufacturers name, brand or model designation, type or grade, and color.

2. Include complete packing lists and bills of materials with each shipment.

3. Tag or mark each equipment item as shown on the packing lists and bill of material.

C. Protect all materials and equipment from exposure to the elements.

1. Keep dry at all times.

2. Protect insulation, controls and electrical equipment from moisture and water damage.

3. Handle and store to prevent damage.

4. Comply with the manufacturer’s recommendations.

D. Store equipment with antifriction or sleeve bearings (e.g. pumps, motors, etc.) in weather-tight areas.

1. Maintain at a temperature above 60 degrees Fahrenheit (°F).

2. Connect space heaters and operate continuously during storage.

E. Do not install equipment or material with rust, pitting decay or other deleterious defects. Such items shall be repaired or replaced as directed by the engineer.

1.05 SPECIAL TOOLS AND SPARE PARTS

A. Provide spare parts recommended by the manufacturer.

1. Pack spare parts in wooden boxes or strong weatherproof cartons. Pack for export.
2. Label with the manufacturers name, address, and telephone number; the local representatives name, address, and telephone number; and the name of the equipment the parts are for.

3. List all parts contained in the box.

B. Store in a location designated by the engineer.

C. Furnish one complete set of all special tools required to disassemble, service, repair, or adjust the equipment.

1.06 JOB CONDITIONS

A. The Drawings indicate the extent, and general arrangement of equipment, piping, ductwork and similar items.

1. Equipment provided must fit into the space available.

2. Allow adequate clearance for entry, installation, replacement, servicing and maintenance.

3. Verify actual field conditions prior to ordering materials or equipment.

4. Submit adjustments or modifications from the layout shown on the Drawings to the engineer for approval with the shop drawings. No changes to the layout shall be permitted without the engineer’s written approval.

B. Coordinate the work so equipment may be moved into place without altering building components, other equipment or installations. Provide drops, rises, offsets, or similar items required for proper installation whether shown on the Drawings or not.

1.07 SAFETY REQUIREMENTS

A. Enclose or provide guards for belts, pulleys, chains, gears and other rotating parts to protect operating personnel.

B. Guard or cover high temperature equipment and piping with insulation to protect personnel and prevent a fire hazard.

C. Provide items such as catwalks, ladders and guardrails, where required, for safe access, operation or maintenance of equipment.

D. Provide safe working space around equipment.

1.08 SEQUENCING AND SCHEDULING

A. Coordinate mechanical work with the building construction and other related parts of the Work.

B. Verify that all structures, piping, wiring, conduits and equipment components are compatible.

1.09 MANUFACTURERS SERVICES

A. Inspect and provide written approval of the final installation prior to energizing the equipment.

B. Operate all equipment and make final adjustments, if required, prior to testing.

C. Instruct County personnel in the proper operation and maintenance of the equipment. The times and location of instruction sessions shall be approved by the Engineer.
PART 2 PRODUCTS

2.01 GENERAL
   A. Design and furnish equipment to ensure parts and items for equipment, piping, ductwork, motors and other appurtenances are interchangeable.
   B. Assemble, coat, and paint mechanical equipment in the factory as much as is practicable before shipping and handling. A factory applied prime coat is the minimum coating requirement.
   C. Attach a metal nameplate to each major equipment component. Show at least the manufacturer's name, address and equipment model number.
   D. The Contractor may purchase these items from manufacturers in addition to those named in the technical specifications.
      1. Items provided shall comply with the requirements specified in the technical sections, including quality.
      2. Manufacturers named in the technical specifications shall establish the type, function, dimensions, appearance, and minimum acceptable quality.

2.02 EQUIPMENT BASES
   A. Unless otherwise indicated, provide equipment with a concrete base.
      1. Make base a minimum of four inches high.
      2. Concrete shall meet requirements of Section 03300.
   B. Use cast iron or welded steel equipment base plates. Support each unit and its drive assembly on a single base plate.

2.03 ANCHOR BOLTS
   A. Provide Type 304 stainless steel anchor bolts, nuts and washers meeting requirements of Section 05500.
      1. Unless otherwise indicated, size anchor bolts to the largest diameter that will pass through the bolt holes of the equipment base.
      2. Make the length of the bolts long enough to permit a minimum of one inch of grout beneath the base plate and a minimum of three inches anchorage into the structural concrete.
   B. Provide template or setting drawing sufficiently in advance of installation to permit anchor bolts to be set either prior to or during structural concrete placement.

2.04 SUPPORTS AND BRACES
   A. Provide supports and braces as required.
   B. Fabricate in accordance with Section 05500, Section 15140, or as shown on the drawings.

2.05 DRIVE UNITS
   A. Provide all gear and speed reducers with a nominal input horsepower rating equal to or greater than the nameplate horsepower of the drive motor.
   B. Design for 24 hour continuous service.
   C. Motor and drive gears shall be rated AGMA Class II and shall bear an AGMA nameplate.
D. Provide totally enclosed, oil lubricated gear reducers with anti-friction bearings throughout.
   1. Worm gear reducers shall have a minimum service factor of 1.20.
   2. Other helical, spiral bevel and combination bevel-helical gear reducers shall have a service factor of at least 1.50.
   3. Each gear reducer shall bear an AGMA nameplate.

E. Provide a sliding base or other suitable tension adjustment mechanism for each V-belt drive. V-belt drives shall have a minimum service factor of 1.60 at maximum speed.

2.06 COUPLINGS, BEARINGS, JOURNALS AND KEYS

A. Provide, a standard self-aligning forged steel flexible coupling between each motor and its driven equipment unless specified otherwise.
   1. Fix one hub of the coupling and key it to the driven equipment shaft.
   2. Fix the other hub and key it to the abutting drive shaft.
   3. Place the coupling as close as possible to the driven equipment and the motor bearings so units are arranged in a compact manner.
   4. Use only an all metal coupling that is both moisture and dust proof.

B. Bearings shall be of the ball or roller type with both inner and outer races.
   1. Make the balls or rollers from heat treated steel.
   2. Size balls or rollers to carry the maximum loads without flaking, spalling or crushing.
   3. Space balls evenly and hold them in position by continuous spacing or retainer glands.
   4. Bearings, except for those specifically requiring oil lubrication, shall be pressure grease lubricated.

C. Size and proportion journals and bearings to create the least wear and overheating under all conditions.
   1. Where required, include provisions for easy removal and adjustments.
   2. Line journals with babbitt metal hammered into grooves and bored in place, when required.

D. Secure keys, nuts and other parts which may work loose with locking devices.

2.07 FLANGES, JACKING SCREWS, AND EYE BOLTS

A. Drill flange bolt holes and spot face the flanges on the back. Do not drill holes for stud bolts completely through the flange.

B. Provide jacking screws for covers, where required for leveling.

C. Provide eye bolts for lifting covers and equipment where manual lifting would be difficult.

2.08 BOLTS, NUTS, AND WASHERS

A. Fabricate bolts, nuts and washers of stainless steel meeting the requirements of Section 05500.
   1. Nuts shall be cold pressed.
   2. Bolts, nuts and threads shall be American Standard sizes.
B. Hot dip galvanize all ferrous bolts, nuts and washers except those used for flanged pipe, valves, fittings and equipment connections.

2.09 SAFETY GUARDS
A. Cover all belt and chain drives, fan blades, couplings, shafts and other moving and rotating parts on all sides by a safety guard.
   1. Fabricate safety guards from either 16 or heavier galvanized or aluminum clad sheet steel or 1/2 inch mesh galvanized expanded metal.
   2. Design each guard for easy installation and removal.
B. Provide the necessary supports and accessories including bolts for each guard.
   1. Galvanize or paint supports and accessories, including bolts.
   2. Comply with Section 09900.
C. Design safety guards in outdoor locations to prevent the entrance of rain and dripping water.
D. Comply with applicable OSHA requirements.

2.10 ACCESS DOORS AND PANELS FOR MECHANICAL EQUIPMENT
A. Provide access doors or removable panels for mechanical components that require periodic maintenance and lubrication.
B. Design doors or panels to provide easy access to the required components.

2.11 LUBRICATION
A. Design equipment such that lubrication is required no more frequently than once per week during continuous operation.
   1. Make lubrication facilities, oil drains and fill openings accessible from the normal operating area or platform.
   2. Provide drain ports that allow for the collection of waste oil in containers from operating area or platform without removing the unit from its installed position.
B. Use Zerk Hydraulic or Alemite type Pressure grease fittings.
   1. Locate grease fittings to be accessible by the grease gun provided.
   2. Provide two hydraulically operated grease guns, each suitable for use with type of grease fittings provided on the equipment.

2.12 SHOP PAINTING
A. Prepare the surface and shop coat all equipment, supports, piping, duct work and appurtenances as specified in Section 09900 and as shown on the Drawings.
B. Do not paint connecting ends or any other location where it would hinder installation.
   1. These points shall be shop primed and field painted after installation.
   2. Shop primer shall be compatible with the field coat.

2.13 SPECIAL TOOLS AND ACCESSORIES
A. Provide all special tools, instruments and accessories necessary to adjust, maintain, lift or repair the equipment provided.
   1. Include all items that are not readily available from a commercial tool supplier such as “Snap-on” or Mac tools.
B. Provide a separate metal tool box to store all special tools and accessories for each equipment item.

PART 3 EXECUTION

3.01 PREPARATION

A. Inspect area and surfaces to receive mechanical equipment piping, duct work and appurtenances.
   1. Verify that areas are ready for installation.
   2. Repair defects and damaged areas and adjust surfaces and areas so they are ready for proper installation.

B. Field measure area to be occupied by mechanical equipment and appurtenances.
   1. Verify space is adequate and in accordance with approved Contractor's drawings.
   2. If adjustment is required, obtain approval of Engineer and adjust as approved.

3.02 INSTALLATION

A. Install equipment and appurtenances in accordance with both the manufacturer’s instructions and the Contract Documents.
   1. Make final connections to piping, ducting, electric service and controls.

B. Provide isolation valves on each side of equipment to allow it to be removed or isolated for maintenance.
   1. Provide manual vents at high points in piping.
   2. Provide manual drains at low points in piping. Fit the drains with hose adapters.

3.03 FOUNDATIONS, BASES AND SUPPORTS.

A. Support all equipment, ductwork, electrical conduits and piping using compatible frames, braces, hangers and anchors.

B. Install floor mounted equipment on reinforced concrete pads at least four inches high, unless otherwise shown or required.

C. Install horizontal and vertical pumps mounted on baseplates or pedestals in accordance with Hydraulic Institute Standards and the pump manufacturer’s recommendations.
   1. Level the baseplate or pedestal using shims or wedges.
   2. Anchor the baseplate to the concrete pad using anchor bolts set in pipe sleeves.
      a. Fill the space between the baseplate or pedestal and the concrete pad, and the void between the anchor bolt and pipe sleeve with quick setting, non-shrink, non-metallic grout.
      b. After the grout has hardened, tighten the anchor bolts to equipment manufacturer’s recommendations.
      c. Cut off bolts not more than one inch nor less than 1/2 inch above the anchor bolt nut.

D. Install other vibrating/rotating, mechanical, floor mounted equipment like fans with vibration isolators between the equipment base and raised concrete pads.

E. Anchor all heavy duty, centrifugal air compressors and blowers as required by the equipment manufacturer.

F. Brace and support equipment suspended inside buildings to provide a rigid installation.
1. Attach supports and hangers to bearing walls, roof and floor supports, or framing members.

2. Provide cross bracing as required to develop a rigid installation.

3. Provide vibratory equipment with cushioning and anti-vibratory material as shown on the Drawings and as recommended by the equipment manufacturer.

3.04 ACCESS PANELS AND DOORS FOR CONCEALED EQUIPMENT
   A. Provide access panels or hinged doors at all locations where it will be necessary to access equipment for maintenance or servicing.

3.05 LUBRICATION
   A. Lubricate equipment in accordance with manufacturer’s instructions prior to the initial operation.
   B. Re-lubricate all equipment following testing and prior to final acceptance.

3.06 ADJUSTMENTS AND INITIAL EQUIPMENT OPERATION
   A. Clean piping, ductwork and equipment before initially starting equipment and systems.
   B. Check moving parts for freedom of movement, alignment and adjustment.
   C. Provide air handling units with temporary filters to protect permanent filters.

3.07 SURFACE TOUCH UP AND FIELD PAINTING
   A. Touch up surfaces where shop coats have been damaged. Use paint, coatings, and film thickness identical to the original shop coat.
   B. Clean field installed bolts, nuts, washers and support systems. Paint or coat these items identical to original shop coat and/or surrounding area.
   C. Field paint as specified in Section 09900 and as shown on Drawings.

3.08 PROTECT AND CLEAN
   A. Protect equipment from construction dust and debris during and after installation.
      1. Provide temporary protection as required.
      2. Protect until equipment is in operation or receipt of Certificate of Substantial Completion.
   B. Clean all equipment and the surrounding area.
   C. Clean ductwork both inside and outside.
   D. Replace filters on all air-handling equipment.

3.09 EQUIPMENT LABELS AND NAMEPLATES
   A. Provide stainless steel nameplates fastened with stainless steel pins or screws.
   B. Identify the name of the manufacturer, model number, rated horsepower, speed, and all other pertinent data.
   C. Attach the nameplates to each motor and piece of equipment. Refer to the technical specifications for each type of equipment.

3.10 FIELD QUALITY CONTROL AND TESTING
   A. Perform field inspection and testing in accordance with Section SP-18 and General Provisions.
B. Make adjustments or replace defective equipment and parts, as required to achieve satisfactory performance.

END OF SECTION
SECTION 15075
PIPE AND FITTINGS

PART 1 GENERAL

1.01 DESCRIPTION
A. Provide and test plant piping and fittings as specified and as shown on the Contract Documents. Piping schedule and piping materials data sheets are included in this Section.

B. Related Sections
1. Painting – Section 09900
2. Valves and Appurtenances – Section 15076
3. Valve Operators (Powered) – Section 15078

1.02 QUALITY ASSURANCE
A. Comply with applicable portions of General Provisions and Section 15050.

B. Provide components that are the standard product of a manufacturer regularly engaged in the production of the required materials and equipment.
   1. Use only new components.
   2. The manufacturer shall be responsible for the design, construction and proper operation of all components.

C. Comply with applicable standards including, but not limited to, the most recent edition of the following:
   1. American Water Works Association (AWWA)
      a. C110 – Ductile iron and gray iron fittings, 3 inch through 48 inch for water and other liquids.
      b. C111 – Rubber gasket joints for ductile iron pressure pipe and fittings.
      c. C115 – Flanged ductile iron pipe with threaded flanges.
      d. C150 – Thickness design of ductile iron pipe.
      e. C151 – Ductile iron pipe, centrifugally cast, for water and other liquids.
      f. C301 – Prestressed Concrete Pressure Pipe, Steel Cylinder Type
      g. C304 – Standard for Design of Prestressed Concrete Cylinder Pipe
      a. A307 – Specification for Carbon Steel Bolts and Studs, 60,000 psi tensile strength.
      e. D1784 – Specification for Rigid PVC Compounds and CPVC Components.
      f. D1785 – Specification for PVC Plastic Pipe, Schedules 40, 80 and 120.
g. \text{D2464} – Specification for Threaded PVC Plastic Pipe Fittings, Schedule 80.

h. \text{D2466} – Specification for PVC Plastic Pipe Fittings, Schedule 40.

i. \text{D2467} – Specification for PVC Plastic pipe Fittings, Schedule 80.


3. American National Standards Institute
   a. \text{B16.22} – Wrought Copper and Copper Alloy Solder Joint Pressure Fittings.

D. Design to provide satisfactory performance under the specified operating conditions.

E. Inspections
   1. Manufacturer shall inspect products at factory, prior to shipment, for compliance with these specifications.
   2. Visually inspect pipe and fittings at time of delivery, prior to lowering items into the trench for installation.
      a. Do not use defective materials.
      b. With the approval of the Engineer, cut off defects at least 12 inches from the break, in the sound material of the barrel.
      c. Immediately remove rejected material from the project site.

F. Welding
   1. Provide AWS-certified welding inspector, qualified in accordance with AWS QC1, and who has prior inspection experience with the types of welds specified herein.
      a. Use radiography, ultrasonic, magnetic particle, and other non-destructive testing as specified.
      b. Certify that welding is in accordance with these specifications.
      c. The inspector’s duties include but are not limited to the following:
         (1) Verify job materials and component storage.
         (2) Assess welder qualifications.
         (3) Certify use of approved welding procedures.
         (4) Maintain records and issue timely reports.
         (5) Notify Engineer of unsatisfactory work within 1 hour of observing improper welding and within 24 hours of a weld test failure.
   2. Qualify welders and welding operators prior to performing any welding under this section.
      a. Test in accordance with Section IX, Article III, of the ASME Boiler and Pressure Vessel Code.
(1) Make groove welds in each different pipe material in positions 2G and 5G for each welding process to be used.

(2) Include carbon steel and stainless steel pipe as applicable.

b. Tests may be waived if evidence of prior qualification is satisfactory to the Engineer.

c. Retest a welder when the Engineer considers the quality to be substandard.

(1) The cost of such re-testing will be at the County’s expense if the welder successfully passes the test.

(2) All costs will be the Contractor’s responsibility if the welder fails the re-test.

G. Safety

1. Identify safety features on the shop drawings.

2. Show all safety features required by current codes and regulations including, but not limited to the following:
   a. OSHA
   b. MOSHA
   c. ANSI
   d. Local industrial codes.

1.03 SUBMITTALS

A. Comply with Section SP-09. Include the following information:

1. Manufacturer’s catalog information and engineering data that describes each type of pipe, fitting, coating, and lining provided. Include
   a. Specifications
   b. Mill test certificates
   c. Certified test reports.

2. Installation and repair procedures.

3. Shop drawings
   a. Fabrication drawings for shop-fabricated piping.
   b. Layout drawings for each piping system showing the following as a minimum:
      (1) Pipe material, class, grade, joint type, coating system and lining system.
      (2) Reinforcing details
      (3) Joint and gasket dimensions.
      (4) Anchors, supports, hangers, saddles, straps, and other accessories. Identify the type by catalog number or shop drawing detail number.
      (5) Use AWS welding symbols to show welded connections. Indicate the net weld length.
(6) Fittings, couplings, joints, and joint harnesses.
(7) Centerline elevations.
(8) Location, size, and type of anchor bolts.
(9) Wall and floor penetrations. Include sleeves, castings, sealant, escutcheons, and other accessories.
(10) Complete bill of materials.
(11) Orientation of valves and valve operators.
(12) Critical clearances.
(13) Thrust restraint. Address materials, sizes, assembly ratings and pipe attachment methods for each type of pipe.
(14) Expansion compensation.
(15) Insulation.
(16) Pipe coatings.
(17) Pipe identification.
(18) Miscellaneous details required for a complete and functional installation.

c. Laying schedules for underground piping systems. As a minimum, identify the following:
   (1) Pipe invert station and elevation at each grade and alignment change.
   (2) Pipe length as measured along the centerline.
   (3) Limit of each reach of pipe thickness class and joint restraint system. Include design calculations.
   (4) Limits of concrete encasement.
   (5) Location of valves and other mechanical equipment.
   (6) Details of special piping and fittings.
   (7) Thrust block details. Include concrete quantity, bearing area on pipe and fitting locations.
   (8) Joint information for dissimilar pipes.
   (9) Joint deflection (both horizontal and vertical).
   (10) Test pit information as indicated on the drawings or as required by the Engineer.

4. Restrained joint details. Include:
   a. Calculations.
   b. Drawings showing where each type of restrained joint is used. Mechanical joints may not be used as a restrained joint.
   c. Prestressed cylinder pipe restrained joint to be snap ring or harness clamp coupling.
   d. Identify actual field experience. Provide references.
B. Submit certified test reports.
   1. Certify compliance with AWWA and ASTM standards and these specifications for all pipe and fittings.
   2. For ductile iron pipe 16-inches-in-diameter and larger, submit written transcript of tensile and impact test results.
      a. Include low temperature impact test.
      b. Comply with AWWA C151 for test frequency and selection of test specimens.
      c. Indicate pipe size in inches, class, date and casting period.
   3. Unless noted otherwise, no pipe or fittings will be accepted until the required certificates are submitted and approved by the Engineer.

C. Pipeline Inspections and Tests
   1. Submit detailed plan for filling and testing pipeline sections, at least 30 days prior to testing. Include:
      a. Test procedures.
      b. Locations for necessary equipment and materials.
      c. Date and duration of tests.
   2. Test records with a certificate of satisfactory completion signed by both Contractor and Engineer. Include the following:
      a. Test date.
      b. Identify of pipeline being tested or re-tested.
      c. Pipeline material.
      d. Test fluid.
      e. Test pressure.
      f. Remarks:
         (1) Identify types and location of leaks.
         (2) Identify types of repairs.
      g. Contractor’s certification that the measured leakage rate conforms to these specifications.
      h. Signature of County’s representative witnessing the test.

1.04 PRODUCT DELIVERY, STORAGE AND HANDLING
   A. Deliver, handle, and store the equipment in accordance with Section SP-14.
   B. Packing and Shipping
      1. Securely plug or cap open pipe ends before leaving the factory or shop.
      2. Protect threads.
3. Protect, support, and handle products to prevent damage to linings and coatings.
   a. Tightly close the ends of cement mortar lined pipe with polyethylene plastic wrap to protect pipe during shipment.
   b. Leave plastic wrap on pipe until installed.

C. Delivery
1. Coordinate with installation.
   a. Where feasible, unload and store along the line of work outside of the trench limits and as near as practical to the point of final placement. Wedge secure.
   b. Have wall pipes and sleeves available for placement in concrete forms.
2. Use heavy canvas or nylon slings to lift pipe and fittings. Do not use chains or cables.
3. Do not drop or dump pipe into trenches.
4. Remove damaged pipe from the project site.

D. Storage and Protection
1. Store coated pipe, fittings, valves and appurtenances off the ground.
   a. Use sound wood blocks on a stable foundation, or some other means, to support the items.
   b. Provide space between rows, between individual pieces and both above and below the items to allow full view for inspection.
2. Store in a well-drained area away from brush, poison oak or ivy, and in an area that is accessible for inspection.
3. Where necessary, provide shelter and apply water to prevent excessive drying.
4. Do not stack pipe higher than 54-inches at the work site.
5. Keep the spigot end of pipes clean and clear for dimensioning.
6. Do not place excavated material against the stored items.
7. Cover PVC and CPVC pipe that is stored outside with an opaque material to protect against UV degradation.
8. Store rubber gaskets in a cool, well ventilated area.
   a. Do not expose to the direct rays of the sun.
   b. Do not allow contact with oils, fuels, or petroleum solvents.

PART 2 PRODUCTS
2.01 GENERAL
A. The Specifications and Drawings do not purport to show all piping details including supports necessary for a successful installation.
1. Provide a complete piping system suitable for its intended use and in compliance with applicable laws and regulations.
2. Size and provide adequate supports for all work regardless of whether or not they are shown on the drawings.
B. Pressure ratings presented in the attached schedules are the minimum acceptable.

C. Design
   1. Piping
      b. Drainage, Waste, and Vent: BOCA Uniform Plumbing Code
      c. Buried Piping: AASHTO H-20 traffic loads with 1.5 impact factor.
         Design for operation both with and without internal pressure.
   2. Thrust Restraint
      a. Test Pressure: As scheduled
      b. Soil Bearing Pressure: 2,000 psf.

D. Water in the excavation
   1. Do not lay or test pipe with water in the trench.
   2. Do not open more trench than the available pumping facilities can adequately
dewater.
   3. Dispose of water so as to not injure or interfere with normal drainage.
      a. Do not use the installed pipelines as drains.
      b. Plug the ends of installed pipelines with approved stoppers to prevent
         the entrance of mud, sand or other obstructing matter.

E. Clean all pipelines to the satisfaction of the Engineer prior to testing.

2.02 PIPE AND FITTINGS

A. Piping systems are identified on the Drawings. Refer to the Piping Schedule and Piping
   Material Data Sheets for specific materials of construction, joint types, and other
   requirements.
   1. Use push-on or mechanical joints for buried ductile iron pressure piping.
   2. Use flanged joints for exposed or submerged, ductile-iron piping.

B. Use a single manufacturer to provide all pipe and fittings of the same size and material.
   Clearly mark the manufacturer’s name or trademark on each length of pipe and on each
   fitting.

C. Pipe diameters referenced on the Drawings and in the Piping Schedule shall be as
   follows:
   1. Ductile iron, mill-type steel, and PVC pipe: Nominal sizes for the standardized
      products.
   2. Fabricated-steel pipe: Outside diameter in accordance with ANSI B36.10.

D. Flange Bolts, Nuts, and Washers
   1. Indoor locations including enclosed vaults and structures:
      a. Galvanized carbon steel
      b. Conform to ASTM A307, Grade B.
   2. Outdoor exposed locations and all submerged applications:
      a. Type 316 stainless steel
b. Conform to ASTM A193, Grade B8M for bolts.
c. Conform to ASTM A194; Grade 8M for nuts and washers.
d. Treat with Molykote P37 (Dow Corning or equal) to prevent seizing.

E. Galvanizing
1. Hot dip applied in accordance with ASTM A153
2. Do not use zinc electroplating or cadmium plating.

F. Linings and Coatings
1. Use a single applicator firm to apply linings and coatings to all ductile iron pipe and fittings.
   a. Application firm shall be certified, experienced and qualified.
   b. Applicator shall certify that the linings and coatings have been applied in accordance with these specifications.
2. Apply only to new (unused) pipe and fittings.
3. Test for holidays and pin holes using a Tinker & Rasor or K-D Bird Dog holiday detector.
4. Coat the exterior of exposed, buried, and submerged ductile iron pipe and fittings as specified in Section 09900 for the appropriate piping system.

G. Shop Fabricated Piping
1. Provide in accordance with approved laying drawings.
2. Fabricate outlets and bends so that they will be located as shown on the laying drawings when installed.
3. Mark each pipe and fitting on the outside with the following:
   a. Size or diameter.
   b. Pipe class.
   c. Manufacturer’s identification and pipe serial number.
   d. Location number on laying drawing.
   e. Date of manufacture.
4. Indicate code markings according to reviewed shop drawings.

2.03 JOINT RESTRAINT

A. Provide restrained joints for all buried piping.
1. Submit thrust calculations for each piping system to Engineer for approval. Provide a minimum factor of safety of 3.0.
2. Use only with ductile iron pipe and fittings.
   a. Do not exceed 80 percent of the manufacturer’s recommended deflection.
   b. Treat surcharged gravity pipe lines as pressure pipes.
3. Design in accordance with the Ductile Iron Pipe Research Association (DIPRA) standards.
4. Thrust blocks may be used in lieu of restrained joints, if sufficient space is available.

B. Provide restraint by using either ductile-iron retainer rings joined by high strength, T-head bolts, or by a welded-on retainer ring with a split flexible ring assembled behind the retainer ring. Acceptable products include:
   1. Flex-Ring, Lok-Ring, or Fast-Grip, as manufactured by the American Cast Iron Pipe Company.
   2. TR Flex Type as manufactured by the United States Pipe Company.
   3. Or Equal.

C. With prior approval of the Engineer, the Contractor may be allowed to restrain mechanical joints using a follower gland that includes a “built-in” restraining mechanism.
   1. Mechanism must impart multiple wedging actions against the pipe wall.
   2. Resistance must increase as the internal pipe line pressure increases.
   3. Joint must retain its flexibility after restraint is installed.
   5. Provide twist off nuts for the restraining wedges to ensure they are installed at the proper torque.
   6. MEGALUG, as manufactured by EBAA Iron, Inc., is the only acceptable product for these alternative restraining devices.

D. Joint to be provided with corrosion protection.

PART 3 EXECUTION

3.01 FIELD EXAMINATION

A. Verify that field conditions affecting pipe installation are as depicted on approved shop drawings.
   1. Expose existing pipe lines that are to be connected to new pipe lines.
   2. Verify the size, material, joint type, horizontal and vertical alignment and the pipe service.

B. Verify the size and the location of structure penetrations, equipment connections and similar items prior to installing connecting pipes.

3.02 PREPARATION

A. Inspect all pipe and fittings for damage immediate prior to installation.
   1. Repair or replace damaged as directed by the Engineer.
   2. Use material equal to the original to make repairs.
   3. Use a holiday detector in accordance with AWWA C210 to determine the extent of damage to epoxy-coated pipe and fittings.
      a. Repair coatings or replace pipe or fitting as directed by the Engineer.
      b. Follow the repair procedures outlined in AWWA C210.
      c. Follow the coating manufacturer’s instructions. Use only experienced personnel.
d. Verify effectiveness of repairs using holiday detector.

B. Thoroughly clean pipe ends and remove dirt and debris from inside all pipe and fittings. Ensure that items remain clean both during and after installation.

3.03 INSTALLATION

A. General

1. Install all pipe and fittings in accordance with the instructions of the manufacturer, these specifications, and the approved shop drawings.
   a. Adjust horizontal and vertical pipe alignment as approved by the Engineer to avoid architectural, structural or equipment interferences.
   b. Run horizontal piping parallel and perpendicular to building walls, floors, and ceilings where practical.
   c. Group and support parallel piping on the same horizontal or vertical plane where practical.
   d. Install vertical piping plumb, and support each pipe length.
   e. Provide sufficient unions, mechanical couplings or similar items to allow any pipe section, valve or equipment item to be removed without disconnecting adjacent piping runs.
   f. Install pipe, fittings, and valves with sufficient clearance for painting and preventive maintenance.
   g. Do not obstruct openings or reduce headroom to less than 7 feet 6 inches.
   h. Use eccentric reducers installed with the flat side on top, unless otherwise shown on the drawings.
   i. Provide isolating valves at each piece of equipment and on all supply and return lines.
   j. Locate valves and pipe mounted instruments so that they will be easily accessible by the equipment operator.
   k. Clean new pipelines by flushing prior to testing.
      (1) Remove all dirt, stones and debris that may have entered the pipeline during construction.
      (2) Furnish water for flushing and dispose of debris.

2. Joints

   a. Threaded
      (1) Comply with ANSI B2.1. Cut threads full and free from torn or ragged edges.
      (2) Ream the full diameter of the pipe end.
      (3) Apply Teflon tape to the male threads only. Do not use thread cement or caulking.
      (4) Expose no more than three threads after installation.
      (5) Do not use sharp-toothed pipe wrenches to assemble copper or brass pipe.
b. Flanged
   (1) Remove rust-preventive compound before installation.
   (2) Lubricate bolts, studs, and nuts with graphite and oil so that the nuts can be turned by hand.
   (3) Make joints square, with even pressure on the entire gasket. Joints must be gas and water tight.
   (4) Accurately fit gaskets to the inside of the pipe with no surplus material projecting into the flow area.
   (5) If a raised face flange is to be connected to a flat faced flange, either remove the raised face or use a machined spacer to allow bearing over 100 percent of the flange face.

c. Soldered
   (1) Cut tubing square and remove burrs.
   (2) Clean both the inside of the fitting and the outside of the tubing with emery cloth or similar abrasive before making the joint. Clean at least ½ inch beyond the joint line.
   (3) Prevent annealing of fittings or hard-drawn tubing when making connections.
   (4) Use 95-5 wire solder conforming to ASTM B32, Grade 95 TA to make the joint. Do not use soft solder or cored solder.
   (5) Use flareless compression type fittings for tubing.

d. Dissimilar Pipe
   (1) Provide dielectric joints at connections of dissimilar metals. Conform to NACE RP-0286.
   (2) Use flexible mechanical compression joint couplings on buried piping.
   (3) Test joints to verify non-conductivity.

3. Expansion and Contraction
   a. Install piping to allow for thermal expansion and contraction due to differences between installation and operating temperatures.
   b. Provide anchors sized to withstand expansion thrust loads and to direct and control thermal expansion.
      (1) Provide intermediate pipe guides for every pipe. Locate at each support not carrying an anchor or alignment guide.
      (2) Install pipe alignment guides within four pipe diameters of expansion devices.
   c. Provide the specified expansion devices at the locations shown on the drawings.

4. Piping Flexibility
   a. Provide flexible couplings with pipe anchors where necessary to facilitate pipe and equipment installation.
5. Slab, Floor, Wall and Roof Penetrations
   a. Use wall sleeves or castings for all piping penetrations of slabs, floors, walls, and roofs unless shown otherwise on the Drawings.
   b. Use wall pieces, provided by the PCCP manufacturer when connecting PCCP pipe to concrete walls. Wall pieces may be spigot or bell type with water stop collar and sized for full wall penetration.
   c. Core drill holes in existing structures.
   d. Verify the size and location of all penetrations prior to pouring concrete.
   e. Support wall sleeves, wall pieces and castings in formwork. Prevent contact with reinforcing steel.

6. Vents and Drains
   a. Provide vents on high points and drains on low points of all piping regardless of whether or not they are shown on the drawings.
   b. Include a suitable ball valve or plug valve for all manual vents and drains.
      (1) For pipes 4-inches in diameter and larger, use a ¾ inch vent and a 1 inch drain.
      (2) For pipes smaller than 4-inches in diameter, use a ½ inch vent and a ¾ inch drain.

B. Buried Piping
1. Lay pipe and fittings in conformance with the Contractor’s approved laying schedule, the manufacturer’s instructions and these specifications.
   a. Comply with AWWA C111 and C600 and AWWA M41.
   b. Minimum cover between finished grade and the pipe crown: 4 feet.
   c. Locate a flexible pipe joint within 18-inches or ½ of the pipe diameter, whichever is less, from each connection to a structure and from the point of stopping concrete encasement.
   d. Changes in horizontal alignment less than 11-1/4 degrees may be achieved using joint deflection, rather than fittings, when approved by the Engineer.
   e. Prevent pipe uplift or floating prior to backfilling the trench.
   f. Do not lay pipe in water or when, in the opinion of the Engineer, trench conditions are unsuitable.
   g. Prevent foreign material from entering pipe and fittings.
   h. Secure the pipe to prevent creep or movement when the next piping section is being laid.
   i. Electrically isolate buried piping at the first joint after entry or exit from a building or treatment vessel.
   j. Install marking tape along the centerline of all pipes on top of the last lift of pipe zone material.
      (1) Install approximately 2 feet deep. Take care to not damage tape. Repair if damaged.
(2) Splice detectable pipe locating tape with clips provided by the manufacturer. Bring to surface inside each manhole or termination structure and install wire clips as recommended by the tape manufacturer.

2. Trench preparation
   a. Do not deviate more than 1-inch from line or ¼ inch from grade for gravity piping.
      (1) Measure for grade at the pipe invert.
      (2) Check each section of pipe with a straight edge and correct discrepancies.
   b. Grade the trench bottom to provide continuous and uniform support between bell holes along the pipe barrel.
   c. Dig holes at each joint to accommodate the pipe bell. Leave ample clearance to allow each joint to be visually inspected and tested.

3. Installation
   a. Lay pipe upgrade with the bell ends pointing in the direction of laying.
   b. Clean the end of the pipe to be joined, the inside of the receiving bell, and the rubber gasket, immediately prior to making the connection.
   c. Verify gasket position and proper seating using a feeler gauge or other suitable device.
   d. Install adapters and closure pieces at locations where gravity pipe changes direction.
   e. Check alignment and grade. Adjust as required.
   f. Joint Deflection
      (1) When pipelines are laid on a curve, unsymmetrical closure of the spigot into the bell may be used to deflect the pipe around the curve.
      (2) Limit deflection to 80 percent of the maximum deflection recommended by the pipe manufacturer or the following, whichever is less.
         (A) Push-on joint pipelines 12-inches in diameter and smaller: 5 degrees.
         (B) Push-on joint pipelines larger than 14-inches in diameter: 3 degrees.
         (C) MJ pipelines: Comply with AWWA C600.
   g. Thrust Restraint
      (1) Install at all tees, crosses, bends, plugs, caps and similar locations where unbalanced forces exist, regardless of whether or not they are shown on the Drawings.
      (2) Install restrained joints in accordance with the manufacturer’s recommendations.
(3) If concrete buttresses are used, the Engineer shall approve the excavation prior to placement.

   (A) Ensure the excavation provides a firm bearing, is flat, and is located at the proper angle to the pipeline.
   (B) Provide wood forming on both sides of the buttress.
   (C) Protect joint bolts from concrete.

(4) Provide temporary blocking if testing is performed before backfilling is complete.

(5) Locate “Restrained Joint Pipe” tape over entire length of all restrained piping prior to backfilling. Do not provide tape for fire hydrant leads.

h. Pipe Coatings

   (1) Apply exterior pipe coatings as required by the detailed pipe specification sheets.

   (2) Pipe Tape Wrap

      (A) Clean the pipe surface to remove all dirt, rust and mill scale. As a minimum, comply with SSPC-SP-1 and SSPC-SP-3.
      (B) After cleaning, immediately prime the pipe using the tape manufacturer’s recommended primer.
      (C) Hand-apply the tape spirally with at least 50% overlap.

   (3) Pipe and fittings with a shop applied epoxy coating system.

      (A) Repair damaged areas after assembly.
      (B) Field coat bolts, nuts, and uncoated metal in accordance with Section 09900.
      (C) Clean, apply and cure field-applied material in accordance with the coating manufacturer’s recommendations.

C. Exposed Piping

1. Provide lateral support for thrust restraint and seismic loads at all changes in direction.

2. Set all flanges level, plumb and aligned such that they are perpendicular to the axis of the pipe.

3. Install such that flange bolt-holes straddle the vertical pipe centerline.

4. Do not spring or force the pipe into place during installation as this will create stresses in the pipe, valves, and connected equipment. Use torque limiting wrenches to tighten bolts.

5. Provide the required straight-run of piping upstream and downstream of flow meters to help ensure their metering accuracy.

6. Provide at least 7-feet, 6-inches of vertical clearance between an obstruction and the nearest walking-working surface.

7. Do not route piping over, or adjacent to, electrical work.
8. Pipe taps
   a. Do not directly tap the pipe barrel.
   b. Use a service saddle or a tapping boss to tap ductile iron piping.
   c. Use a welded threadolet connection to tap steel piping.

9. Insulating Flanges, Couplings, and Unions
   a. Use for the following:
      (1) Copper and ferrous metal piping connections.
      (2) Immersed and non-immersed metallic piping connections.
      (3) Where shown on the Drawings.
   b. Drill oversize holes in the flanges to accommodate insulating sleeves.
   c. Install insulating joints connecting immersed and non-immersed piping above the maximum water level.
      (1) Connect prior to the first pipe support not having coated anchor bolts or adhesive-bonded concrete anchors.
      (2) Isolate all submerged carbon steel, ductile iron, and galvanized piping in reinforced concrete basins from the concrete reinforcement.

D. Welding

1. Comply with Section IX of the ASME Boiler and Pressure Vessel Code and ASME specification B31.3 for pressure piping.

2. Welding techniques, the appearance and quality of welds, and corrective measures employed shall conform to the American Welding Society Code for Arc Welding in Building Construction, Section 4 – Workmanship.
   a. Use continuous welds along the entire line of contact unless tack or intermittent welding is allowed by the referenced standards.
   b. Do not apply coatings until the welds have been inspected by the Engineer.
   c. Use weld materials that comply with AWS D1.1.
   d. Do not fabricate flanged piping in the field.

3. Qualify welders and welding operators prior to performing any welding under this section.
   a. Test in accordance with Article III of ASME-17.
   b. Qualify using groove welds in carbon steel pipe in position 6G for each welding process to be used.

4. Mark each weld with a symbol identifying the person who performed the weld.

5. Procedures
   a. Do not weld if rain, snow, sleet, or high wind contacts the weld area.
   b. Preheat in the vicinity of the weld to a temperature warm to the hand if the ambient temperature is below 32 degrees F.
c. Tack welding
   (1) Remove if not made by a qualified welder using the same procedures as for the final weld.
   (2) If not removed, use same or an equivalent electrode as used for the first weld pass.
   (3) Remove all cracked tack welds.

d. Clean each weld layer with a power driven wire brush prior to depositing each subsequent layer including the final pass. Remove surface defects that may affect the soundness of the weld.

e. Weld passes
   (1) Use at least three for 6-inch diameter and larger pipe.
   (2) Use a minimum of a full root plus a second pass for pipes 4-inch diameter and smaller.

6. Acceptable welds will conform to ANSI B31.3, Chapter V. Fit and groove weld branch connections in accordance with this referenced standard.

7. End Preparation
   a. Machine shape the pipe ends is preferred. Oxygen or arc cutting may only be used if the cut is smooth and true with all slag removed by either chipping or grinding.

8. Quality Control
   a. Visually inspect all welds in accordance with Section 6 of the AWS specifications.
   b. Provide the Owner with access to all welds for inspection and testing purposes.
   c. Repair welds that do not comply with this specification at no additional cost to the Owner

3.04 FIELD PAINTING
   A. Field prepare and paint exposed and immersed surfaces as specified in Section 09900.

3.05 FIELD TESTING
   A. Inspect and test piping systems in accordance with Section 01650 and these specifications.
   1. Buried piping
      a. Perform a hydrostatic test on all pressure piping and on all surcharged sewers. Use either low-pressure-air test or hydrostatic test for non-surcharged sewers.
         (1) If allowed by the Engineer, Contractor may perform initial service leakage test prior to hydrostatic test. Joints may be left open for inspection for this initial leakage test.
         (2) If pneumatic testing is used, conduct with trench only partially backfilled and joints exposed.
(3) Conduct hydrostatic tests only after completely backfilling trench and with required thrust restraints in place.

2. Exposed piping
   a. Perform an initial leakage test; and when that test is successful, perform a hydrostatic test.
   b. Conduct tests only after all supports hangers and anchors have been installed and the installation has been inspected. Do not install insulation prior to testing.

B. Test Protocol
1. Submit proposed test procedures for approval. Include the following information:
   a. Detailed description of test procedures.
   b. Description of test equipment. Include measuring range, accuracy, sensitivity and date last calibrated.
   c. Qualifications of personnel performing the test.
   d. Details of temporary bulkheads, flanges, caps, and similar devices that are required to isolate the piping system for testing.
   e. Proposed test schedule.
   f. Source and method of disposing of test fluid.
2. Provide all equipment and materials necessary to perform the tests.
3. Use the test pressures specified in the piping schedule appended to this section.
   a. Test vents, drains and sample lines at the same pressure as the connected process piping.
   b. Cap or plug relief devices during the test.
4. The Engineer will observe all tests. Provide at least 5 days advance written notice prior to beginning each test.
5. Record the results of each test. Include the following information:
   a. Date of test.
   b. Description of piping system tested.
   c. Test fluid and test pressure used.
   d. Location of any leaks that were identified during the test.
   e. Describe all repairs.
   f. Certification that test was satisfactorily completed. Include a signed acknowledgement by the Engineer.

C. Hydrostatic Tests
1. Use potable water as the test fluid unless specified otherwise.
2. Locate a pressure gauge at the highest point in the piping system.
3. Open vents at the high points of the piping system to release air when the pipeline is filling. Venting may also be accomplished by loosening flanges, as long as they have at least four bolts; and by using equipment vents.
4. Fill the pipeline with the test fluid.
   a. Do not exceed a filling velocity of 0.25 feet per second, applied over the full area of the pipe.
   b. Allow pipeline to stand for 24 hours under low pressure to allow the cement-mortar lining to absorb water.
5. Bring the piping system to the specified test pressure as measured at the highest point in the piping system.
6. Maintain the specified test pressure for the duration of the test. After a minimum of two hours, examine all joints and connections for leaks.
7. Correct any visible leakage or weeping except that which may occur at either pump or valve packing.
   a. Accurately measure the volume of water required to maintain the test pressure in buried piping systems.
   b. Calculate the allowable leakage as follows:
      \[ L = \frac{S \times D \times (P)^{1/2}}{148,000} \]
      Where:
      - \( L \) = Maximum allowable leakage in gallons per hour. This is the total volume of water necessary to maintain the test pressure divided by the test period.
      - \( S \) = Length of pipe tested in feet
      - \( D \) = Nominal pipe diameter in inches
      - \( P \) = Test pressure in psig.
8. Repair and re-test until there is no leakage or until the leakage rate for buried pipelines is acceptable.

D. Pneumatic Testing of Gravity Piping Systems
1. May be used for gravity piping systems covered by the Air Test Tables included with this specifications and that are not surcharged.
   a. Test only after completing backfill.
   b. Begin testing when not more than 1,000 feet of gravity piping has been installed.
      (1) No more than 1,000 feet of gravity piping may be installed in advance of testing, unless approved by the Engineer.
      (2) Do not test until all connections and manholes are completed between the stations being tested.
   c. Test gravity pipelines from manhole to manhole or from manhole to terminus.
   d. Contractor may soak the interior of concrete pipe with water prior to pneumatic testing. Remove all water before beginning the pneumatic test.
2. Plug all wyes, tees, stubs, and lateral connections with gasketed caps or plugs.
   a. Securely fasten or block to withstand the internal test pressure.
b. Make plugs or caps removable; and their removal shall provide a bell suitable for making a flexible jointed lateral connection or extension.

3. Plug each manhole and/or terminus. Securely brace to withstand the internal test pressure.

4. Immediately prior to testing, determine the groundwater height above the drain invert.
   a. Adjust the test pressure to account for the groundwater.
   b. Do not exceed a test pressure of 5.5 psig.

5. Slowly add air to the test section until the internal pipe pressure, as indicated on the test gauge, stabilizes at 4.0 psig or the corrected pressure that accounts for groundwater.
   a. Do not allow personnel in manholes when the piping section is pressurized.
   b. If air leaks occur at the plugs, relieve the air pressure before attempting to correct the problem.

6. When the air pressure stabilizes, disconnect the hose and compressor. Lower the air pressure to 3.5 psig plus the correction for groundwater backpressure.

7. Record the time required for the pressure to drop from 3.5 psig to 3.0 psig (plus the correction for groundwater backpressure). The total pressure drop in 0.5 psig.
   a. Minimum holding times for various pipe diameters are provided in the Air Test Tables appended to this specification.
   b. Pipes that fail to maintain the required minimum holding times set forth in the Air Test Tables will not be accepted.
   c. If the gauge needle does not drop at all after five minutes holding time and the required test duration exceeds five minutes, the piping section will be considered as passing the test.

8. Repair or replace piping sections that fail the low pressure air test. Re-test those sections at no cost to the Owner.

E. Infiltration will not be allowed into any buried gravity pipeline.

F. If test pressure drops greater than 5 psi in the five minute test period, the joint fails and the pipe joint removed and corrections made and re-tested.

3.06 CLEANING

A. Prior to installation, remove debris from the pipe that may have accumulated during fabrication.

B. Flush all installed pipelines except process and instrument air lines with potable water.
   1. Where possible, use sufficient water to produce a minimum velocity of 2.5 fps. For large pipelines where this is not feasible.
      a. Manually brush and sweep the pipe interior.
      b. Flush with water at a lower velocity.
   2. Dispose of flushing water and debris without damaging adjacent properties.
   3. Dry chemical pipelines with compressed air immediately after cleaning.
3.07 DISINFECTION

A. Disinfect all potable water pipeline as specified in Standard Specifications Section 02551.

C. Do not use a water flush on process or instrument air pipelines. Clean these lines using sufficient compressed air to produce a line velocity of at least 4,000 fpm.

D. Insert strainers in flushing connections attached to equipment to catch debris. Leave in place until cleaning is complete.
# PIPING SCHEDULE

<table>
<thead>
<tr>
<th>Service</th>
<th>Legend</th>
<th>Materials (2)</th>
<th>Installation (3)</th>
<th>Max. Operating Temp. (°F)</th>
<th>Max. Operating Pressure (psig)</th>
<th>Test Pressure (psig)</th>
<th>Types of Joints (4)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Air, Plant Utility</td>
<td>A</td>
<td>Cu</td>
<td>Exp</td>
<td>90</td>
<td>50</td>
<td>75</td>
<td>W, SW</td>
</tr>
<tr>
<td>Backwash Air</td>
<td>BWA</td>
<td>SSTL</td>
<td>Bur/Exp/Sub</td>
<td>90</td>
<td>50</td>
<td>75</td>
<td>FL, MJ</td>
</tr>
<tr>
<td>Clarifier Blowdown</td>
<td>CB</td>
<td>DI</td>
<td>Bur</td>
<td>90</td>
<td>10</td>
<td>15</td>
<td>MJ</td>
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<td>CD</td>
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<td>MJ</td>
</tr>
<tr>
<td>Clarifier Influent</td>
<td>CI</td>
<td>DI</td>
<td>Bur/Sub/Exp</td>
<td>90</td>
<td>10</td>
<td>15</td>
<td>FL, MJ</td>
</tr>
<tr>
<td>Filter Effluent</td>
<td>FE</td>
<td>DI</td>
<td>Bur/Sub/Exp</td>
<td>90</td>
<td>10</td>
<td>15</td>
<td>FL, MJ</td>
</tr>
<tr>
<td>Filter Influent</td>
<td>FI</td>
<td>DI</td>
<td>Bur</td>
<td>90</td>
<td>10</td>
<td>15</td>
<td>MJ</td>
</tr>
<tr>
<td>Lime (Slurry)</td>
<td>LIME</td>
<td>PVC</td>
<td>Bur/Exp</td>
<td>150</td>
<td>80</td>
<td>120</td>
<td>FL, SW</td>
</tr>
<tr>
<td>Plant Drains</td>
<td>D</td>
<td>DI</td>
<td>Bur</td>
<td>90</td>
<td>10</td>
<td>15</td>
<td>MJ, PO</td>
</tr>
<tr>
<td>Polymer</td>
<td>POL</td>
<td>CRFT/PVC</td>
<td>Bur/Sub/Exp</td>
<td>90</td>
<td>50 (PVC)</td>
<td>75 (PVC)</td>
<td>B, SW</td>
</tr>
<tr>
<td>Raw Water</td>
<td>RW</td>
<td>DI</td>
<td>Exp</td>
<td>90</td>
<td>50</td>
<td>75</td>
<td>FL, MJ</td>
</tr>
<tr>
<td>Recycle Water</td>
<td>RC</td>
<td>DI</td>
<td>Bur/Exp</td>
<td>90</td>
<td>30</td>
<td>45</td>
<td>FL, MJ</td>
</tr>
<tr>
<td>Roof Drain</td>
<td>RD</td>
<td>DI</td>
<td>Exp/Bur</td>
<td>90</td>
<td>30</td>
<td>45</td>
<td>FL, MJ</td>
</tr>
<tr>
<td>Sodium hypochlorite</td>
<td>NaOCl</td>
<td>PVC</td>
<td>Bur/Exp</td>
<td>90</td>
<td>50</td>
<td>75</td>
<td>SW</td>
</tr>
<tr>
<td>Utility Water</td>
<td>UW</td>
<td>Cu</td>
<td>Bur/Exp</td>
<td>90</td>
<td>80</td>
<td>120</td>
<td>W, SW</td>
</tr>
</tbody>
</table>
PIPING SCHEDULE (CONTINUED)

(1) Refer to piping material data sheets for specific requirements.

(2) Piping Materials

DI = Ductile Iron
PVC = Polyvinyl Chloride
Cu = Copper
SSTL = Stainless Steel
CRFT = Clear Reinforced Flexible Tubing

(3) Installation Legend

Bur = Buried
Exp = Exposed
Sub = Submerged

(4) Joint Legend

FL = Flanged
MJ = Mechanical Joint or Restrained Mechanical Joint as specified.
PO = Push-On or proprietary Push-On Joint as specified.
SC = Screwed
SD = Soldered
SW = Solvent Welded
W = Welded
B&S = Bell and Spigot
B = Barbed
**PIPING MATERIAL DATA SHEET - Ductile Iron (DIP)**

### PIPE DESCRIPTION

| Push-on joint, mechanical or restrained joint pipe 4” and larger | Ductile iron per AWWA C151/ANSI A21.51, latest revision. Cement-mortar lined per AWWA C104/A21.4., Double Thickness with Seal Coat. Thickness per AWWA C150/ANSI A21.50, Minimum Thickness Class 52. Minimum Pressure Class: 4” to 12” – Class 350 14” and larger – Class 250. |
| Flanged joint pipe 3” and larger | Ductile iron per AWWA C115/ANSI A21.15. Cement mortar lined per AWWA C104/A21.4., Double Thickness with Seal Coat. Thickness per AWWA C150/ANSI A21.51, Minimum Thickness Class 53. |

### END CONNECTIONS

| Mechanical joints | Gasketed and bolted per AWWA C111/ANSI A21.11 and AWWA C153. Restained joints required, EBAA Iron “Megalug” or equal. |

### FITTINGS

| All | Material: Ductile Iron ASTM A536. Coatings and linings: Same as pipe. Dimensions AWWA C110, AWWA C111, and AWWA C153, as applicable. End connections same as adjacent piping. |

### SPECIAL REQUIREMENTS

Delete asphaltic coating for interior piping that is to be painted. Provide shop primer per Section 09900. Encase buried pipe in minimum 8 mil Polyethylene tube per AWWA C105. Secure overlap with at least two wraps of polyethylene tape. For 36-inch and larger fittings, clearly mark the year, month, date cast, number lot, and the manufacturer’s fitting control number on each fitting. This is in addition to the marking requirements in AWWA C110. Use CORTEN or equal nuts and bolts for mechanical joints as manufactured by NSS Industries; Plymouth, Michigan. Cover entire face of blind flange with gasket. Cement to blind flange.

### MANUFACTURERS

# PIPING MATERIAL DATA SHEET - Copper (Cu)

## PIPE DESCRIPTION

| Buried – All Sizes | Material: ASTM B88  
|                   | Type: K (Hard Drawn) |
| Exposed – All Sizes | Material: ASTM B88  
|                   | Type: L (Hard Drawn) |

## END CONNECTIONS

| All | Solder  
|     | Compression |

## FITTINGS

| All | Material and Dimensions: ANSI B16.22  
|     | Compression, Brass; Crawford “Swagelok” or Parker-Hanifin “CPI” |

## SPECIAL REQUIREMENTS

Use dielectric couplings at material changes.  
Use two part coupling for copper to copper connections.  Include tubing connection, a coupling nut and a friction ring.  Threaded coupling nuts to conform to AWWA C800.  
Apply polyethylene tape coating to buried piping.  Spiral wrap with minimum 50 % overlap.  
Use tape or heat shrink wrap at joints.  Follow manufacturer’s instructions.

## MANUFACTURER

Mueller Industries.  
Howell Metals Company.  
Or Approved Equal.
<table>
<thead>
<tr>
<th>PIPE DESCRIPTION</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Solvent Welded, Threaded, and Flanged</td>
<td>Material: PVC ASTM D1784, Class 12454-B (Type 1, Grade 1). Dimensions: ASTM D1785, Schedule 80.</td>
</tr>
<tr>
<td>Gasketed pipe (AWWA C-900, C-905 or SDR 35)</td>
<td>Material: PVC ASTM D1784. Dimensions: ASTM F477, F679, D2122, D3034, or D3139, as appropriate.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>END CONNECTIONS</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Integral Bell and Gasket</td>
<td>Materials: Same as pipe. Dimensions: ASTM D2122, D3034 and F679 as applicable. Gaskets: Conform to ASTM F477</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>FITTINGS</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Threaded</td>
<td>Materials and Dimensions: ASTM D1784 and ASTM D2464. Lubricant: Teflon Tape</td>
</tr>
<tr>
<td>Flanged</td>
<td>Materials: Same as adjacent pipe. Dimensions and bolt pattern: Same as pipe. Pressure rating: Same as pipe.</td>
</tr>
<tr>
<td>Integral Bell and Gasket</td>
<td>Materials: Same as adjacent pipe. AWWA C900 and C905 fittings may also be ductile iron. Dimensions: Same as pipe. Pressure rating: Same as pipe.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>SPECIAL REQUIREMENTS</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Use AWWA C900 or C905 piping for buried pressure applications greater than 4-inches. Use DR 35 pipe for buried, gravity flow applications.</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>MANUFACTURERS</th>
<th></th>
</tr>
</thead>
</table>
### PIPING MATERIAL DATA SHEET – Polyvinyl Chloride (PVC) Tubing

<table>
<thead>
<tr>
<th>PIPE DESCRIPTION</th>
</tr>
</thead>
</table>
| Clear Reinforced Flexible Tubing (CRFT) | Material: Spiral steel wire reinforcement incorporated into wall of flexible PVC tubing  
Dimensions: 1/4-inch ID through 2-inch ID |

<table>
<thead>
<tr>
<th>END CONNECTIONS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Make a clean cut perpendicular to the tubing centerline.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>FITTINGS</th>
</tr>
</thead>
</table>
| Multi-Barbed Type | Materials: Nylon, Polyethylene, or Polypropylene that is NSF certified.  
Clamps: Worm gear, screw tightening type constructed of type 301 stainless steel |

<table>
<thead>
<tr>
<th>SPECIAL REQUIREMENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>None.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>MANUFACTURERS</th>
</tr>
</thead>
</table>
| New Age Industries  
Vardex  
Approved Equal |
### PIPING MATERIAL DATA SHEET – Carbon Steel (STL)

#### PIPE DESCRIPTION

2 inch and smaller  
**Material:** ASTM A106.  
**Type:** Seamless  
**Grade:** B  
**Schedule:** 40 unless otherwise noted

2-1/2 inch and larger  
**Material:** ASTM A54  
**Type:** Seamless or electric resistance welded  
**Grade:** B  
**Schedule:** 2-1/2 inch through 6 inch use schedule 40 unless otherwise noted  
6 inch and larger use schedule 20 unless otherwise noted.

#### END CONNECTIONS

Flanged joints  
**Dimensions:** ANSI B16.5, Class 150  
**Material:** Forged carbon steel conforming to ASTM A105  
**Type:** Flat Faced  
**Gaskets:** Cloth insert rubber  
**Bolts:** Carbon steel conforming to ASTM A307, Grade A, Hex head.  
**Nuts:** Carbon steel conforming to ASTM A563, Grade A, Hex head.

Threaded joints  
**Dimensions:** ANSI B2.1  
**Thread Lubricant:** Teflon Tape

Welded  
2-inch and smaller: Socket welded  
2-1/2 inch and larger: Butt welded  
Mark each weld with the symbol of the person making the weld

#### FITTINGS

Flanged  
**Dimensions:** ANSI B16.5, Class 150  
**Materials:** Same as pipe and end connections

Threaded  
**Dimensions:** ANSI B16.3  
**Material:** Malleable Iron, Class 150 conforming to ASTM A197  
**Cast Iron, Class 125 conforming to ASTM A126

Welded  
2-inch and smaller: Socket welded  
2-1/2 inch and larger: Butt welded  
Mark each weld with the symbol of the person making the weld

#### SPECIAL REQUIREMENTS

**Liner**  
Epoxy Line interior of the pipe. Conform to AWWA C213 standard

#### MANUFACTURERS

American Steel Pipe or equal
# PIPING MATERIAL DATA SHEET – Galvanized Steel (GALV)

## PIPE DESCRIPTION

<table>
<thead>
<tr>
<th>Size</th>
<th>Material</th>
<th>Type</th>
<th>Grade</th>
<th>Schedule</th>
</tr>
</thead>
<tbody>
<tr>
<td>2 inch and smaller</td>
<td>Conform to ANSI B31.1; ASTM A53, A134, A135, and A139; and AWWA C200, as applicable.</td>
<td>Seamless or electric resistance welded</td>
<td>B</td>
<td>40 unless otherwise noted</td>
</tr>
<tr>
<td>2-1/2 inch and larger</td>
<td>Conform to ANSI B31.1; ASTM A53, A134, A135, and A139; and AWWA C200, as applicable</td>
<td>Seamless or electric resistance welded</td>
<td>B</td>
<td>2-1/2 inch through 6 inch use schedule 40 unless otherwise noted, 6 inch and larger use schedule 20 unless otherwise noted.</td>
</tr>
</tbody>
</table>

## END CONNECTIONS

<table>
<thead>
<tr>
<th>Type</th>
<th>Dimensions</th>
<th>Material</th>
<th>Type</th>
<th>Gaskets</th>
<th>Bolts</th>
<th>Nuts</th>
</tr>
</thead>
<tbody>
<tr>
<td>Threaded joints</td>
<td>ANSI B2.1</td>
<td></td>
<td></td>
<td>Teflon Tape</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

## FITTINGS

<table>
<thead>
<tr>
<th>Type</th>
<th>Dimensions</th>
<th>Material</th>
<th>Type</th>
<th>Gaskets</th>
<th>Bolts</th>
<th>Nuts</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flanged</td>
<td>ANSI B16.5, Class 150</td>
<td>Malleable Iron, Class 150 conforming to ASTM A197 Cast Iron, Class 125 conforming to ASTM A126</td>
<td>Socket welded</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Threaded</td>
<td>ANSI B16.3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Welded</td>
<td>2-inch and smaller: Socket welded 2-1/2 inch and larger: Butt welded</td>
<td>Mark each weld with the symbol of the person making the weld</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

## SPECIAL REQUIREMENTS

None

## MANUFACTURERS

American Steel Pipe or equal
### PIPE DESCRIPTION

<table>
<thead>
<tr>
<th>Size</th>
<th>Material</th>
<th>Type</th>
<th>Fabrication</th>
<th>Finish</th>
<th>Schedule</th>
</tr>
</thead>
<tbody>
<tr>
<td>3 inch and smaller</td>
<td>A240/A240M.</td>
<td>304</td>
<td>Seamless</td>
<td>No. 1 mill or better</td>
<td>40 unless otherwise noted</td>
</tr>
<tr>
<td>3-1/2 inch and larger</td>
<td>A240/A240M.</td>
<td>304</td>
<td>Electrically welded or seamless</td>
<td>No. 1 mill or better</td>
<td>10 unless otherwise noted</td>
</tr>
</tbody>
</table>

### END CONNECTIONS

**Flanged joints**
- 2-inch and smaller: 150 pound socket welded
- 2-1/2 inch and larger: 150 pound weld neck
- Dimensions: ANSI B16.5, Class 150
- Material: Stainless steel Grade F-316L conforming to ASTM A182
- Type: Raised face
- Gaskets: Conforming to manufacturer’s recommendation for methanol service. Use spiral wound, Type 316 stainless steel strip with flexible graphite filler, and carbon steel centering ring.
- Bolts: Type 316 stainless steel, Hex head.
- Nuts: Type 316 stainless steel, Hex head.

**Welded**
- 2-inch and smaller: Socket welded
- 2-1/2 inch and larger: Butt welded
- Materials: Stainless steel Grade F-316L conforming to ASTM A182

### FITTINGS

**Flanged**
- Dimensions: ANSI B16.5, Class 150
- Materials: Stainless steel Grade F-304 conforming to ASTM A182

**Welded**
- 2-inch and smaller: 2000 pound socket welded conforming to ASTM A182, Grade F-316L
- 2-1/2 inch and larger: Butt welded conforming to ASTM A403/A 403M, Grade WP-316L and ANSI B16.9
- Use long radius 90 degree elbows and tapered, cone type reducers.
- Use standard, commercially available tees, crosses, laterals, and wyes of the socket weld and butt weld type.

### SPECIAL REQUIREMENTS

None

### MANUFACTURERS

Douglas Brothers.
Felker Brothers Corporation
Or Approved Equal.
AIR TEST TABLES – ALL PIPES OTHER THAN RCP

Minimum Holding Time in Minutes: Seconds Required
For Pressure Drop from 3.5* to 3.0* PSIG

<table>
<thead>
<tr>
<th>PIPE DIAMETER</th>
<th>4&quot;</th>
<th>6&quot;</th>
<th>8&quot;</th>
<th>10&quot;</th>
<th>12&quot;</th>
<th>15&quot;</th>
<th>16&quot;</th>
<th>18&quot;</th>
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<th>27&quot;</th>
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</thead>
<tbody>
<tr>
<td>25</td>
<td>2:00</td>
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*Test pressures shall be increased by amount of groundwater backpressure at springline of pipe but shall not exceed 5.5 PSIG.

NOTE: For test sections with a minimum holding time exceeding 5 minutes: If gage needle has dropped 0.0 PSIG from starting pressure after 5 minutes, section will be considered to have passed air test.
SECTION 15076
VALVES AND APPURTEYNANCES

PART 1 GENERAL
1.01 DESCRIPTION
A. Provide manually operated valves, valve bodies for power operated valve assemblies, check valves and appurtenances as specified and as shown on the Contract Documents.
B. Related Work specified elsewhere
1. Basic Mechanical Materials and Methods – Section 15050
2. Pipe and Fittings – Section 15075
3. Valve Actuators – Section 15078
4. Hangers and Supports – Section 15140

1.02 QUALITY ASSURANCE
A. Comply with applicable portions of Section 15050 and General Provisions.
B. Provide components that are the standard product of a manufacturer regularly engaged in the production of the required materials and equipment.
   1. Single manufacturer shall provide all valves of the same type.
   2. Parts for valves of the same size and type shall be interchangeable.
C. Comply with applicable standards including, but not limited to, the most recent edition of the following:
   1. American National Standards Institute (ANSI)
      b. B1.20.1; National Pipe Taper Threads.
      c. B16.1; Cast Iron Pipe Flanges and Flanged Fittings.
      d. B16.5; Steel Pipe Flanges and Flanged Fittings.
      e. B16.18; Cast Copper Alloy Solder Joint Pressure Fittings.
      f. B16.34; Valves – Flanged, Threaded and Welding End.
      b. A276; Stainless Steel Bars and Shapes.
      c. A536; Ductile Iron Castings.
      d. B61; Steam or Valve Bronze Castings.
      e. B62; Composition Bronze or Ounce Metal Castings.
      f. B99; Copper-Silicon Alloy Wire for General Applications.
      g. B271; Copper-Base Alloy Centrifugal Castings.
      h. B371; Copper-Zinc-Silicon Alloy Rod.
      i. D429; Test Methods for Rubber Property – Adhesion to Rigid Substrate.
      j. D1784; Rigid PVC and CPVC Compounds.
k. D2000; Classification System for Rubber Products in Automotive Applications.
m. F439; CPVC Plastic Pipe Fittings – Schedule 80.

3. American Water Works Associations (AWWA)
a. C504; Rubber Seated Butterfly Valves.
b. C508; Swing Check Valves for Water Works Service – 2 inch through 24 inch.
c. C509; Resilient Seated Gate Valves for Water Supply Service.
d. C511; Reduced-Pressure-Principle Backflow-Prevention Assembly.
e. C515; Reduced Wall, Resilient-Seated Gate Valves for Water Supply Service.

D. Valves shall provide satisfactory performance under the specified operating conditions.

1.03 SUBMITTALS

A. Comply with Section SP-09. Identify each valve using the appropriate valve identifier and the tag number shown on the P&ID. Include the following information with the submittal:

1. Manufacturer’s catalog and product information that describes each type of valve provided. Include
   a. Specifications.
   b. A complete bill of materials that identifies all materials of construction.
   c. Preventive/corrective maintenance instructions.
   d. Certification of seat/valve compatibility with the expected process fluid.
   e. Flow performance charts.
   f. Special shipping, storage, protection, and handling instructions.

2. Shop Drawings. Submit separate shop drawings for each type of valve provided. Include:
   a. Layout drawings
   b. Complete nameplate data.

B. Submit compliance certificates for specified tests and design standards.

C. Submit Operation and Maintenance Manuals in accordance with Section SP-10. Also include the following:

1. A list of manufacturer’s recommended parts required to maintain the equipment for a period of one year, with current price information.
2. Manufacturer’s installation instructions.
3. Troubleshooting guide.
4. Detailed operating description for control valves and valves used in modulating service. Identify both normal and limiting operating characteristics.

D. Submit manufacturer’s certificates in accordance with the Sections SP-08.
1.04 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Deliver, handle, and store the equipment in accordance with Section SP-14 and this specification.

B. Handle and store components so as to prevent damage.
   1. Protect finishes, coatings, and appurtenances.
   2. Store valves off the ground and protect against dirt, moisture or foreign material entering the ends.
   3. Protect PVC and CPVC valves against UV degradation. As a minimum, cover with an opaque material.
   4. Store gaskets in original containers and wrappers; and store in a cool, well ventilated area that is protected from the direct rays of the sun. Do not allow contact with oils, fats, or petroleum solvents.

1.05 SPECIAL TOOLS AND SPARE PARTS

A. Provide spare parts as recommended by the manufacturer in their O&M Manual.

B. Furnish one complete set of special tools required to disassemble, service, repair, and adjust the equipment.

PART 2 PRODUCTS

2.01 GENERAL

A. Valves are identified by both type and style. Each style within a particular type of valve is assigned a unique identifier.
   1. As an example, butterfly valves are identified as BFV-1, BFV-2, etc.
   2. The type and style of valve to be used for each application is indicated on the Drawings using the appropriate valve identifier.

B. General Valve Requirements
   1. Valves shall be suitable for the intended service. Provide certificate from an accredited certification organization that the product is suitable for contact with drinking water in accordance with ANSI/NSF Standard 61.
   2. Use the following in metal pipelines unless otherwise shown on the Drawings:
      a. Two-inch-diameter and smaller:
         (1) All brass or bronze except for the handwheel.
         (2) Screwed or soldered ends.
      b. Two-and-one-half-inches-in-diameter and larger
         (1) Iron body, bronze mounted
         (2) Flanged or mechanical joint ends for valves 4-inches in diameter and larger.
         (3) Screwed connections may be used for smaller valves.
   3. Valve shall be the same size as connecting piping. Drawings indicate nominal size unless otherwise noted.
4. Provide end connections that are compatible with connecting piping. See Section 15075 for piping requirements.
   a. Cast flanges and mechanical joint bells at right angles to the casting axis.
   b. Drill and shop coat with a rust-preventive compound prior to shipment.
   c. Provide a union adjacent to all valves with screwed or soldered connections to facilitate removal.

5. Open counter-clockwise.

6. Equip non-rising stem valves with a suitable position indicator.

7. Provide rising-stem valves with a clear stem guard that is calibrated to indicate stem position.

8. Connect extension stems to valves using bronze couplings.
   a. Size to withstand all stresses without deformation. Use a minimum safety factor of six.
   b. Fabricate and install stems to operate valve without binding.

9. Provide the manufacturer’s name and valve size on the body or bonnet of the valve. Use
   a. Cast letters, or
   b. Provide permanently attached plate with information stamped in raised letters.

C. Furnish valves complete with operators, extension stems, floor stands, operating wrenches and all other appurtenances necessary for them to perform as designed. Mount actuators and appurtenances in the factory and ship as a unit.

1. Manual operators
   a. Provide a handwheel for conveniently accessible valves.
   b. Provide a chainwheel operator for all manual valves greater than 6 feet above the finished floor or working surface.
      (1) Extend the chain to within 4 feet of the floor or working surface.
      (2) Secure chain using hooks fastened to walls or other parts of the structure. Locate hooks so that the chain does not obstruct access ways.
   c. Size handwheels and chainwheels and provide actuator gearing to limit the maximum operating force to 80 pounds. Include floor stands, floor boxes, and extended actuators where shown on the Drawings.
   d. Include stem extensions, valve boxes, position indicators, and tee wrenches for buried valves.
      (1) Provide 2-inch square AWWA operating nut.
      (2) Locate operating nut no more than 12 inches below grade.

2. Automatic operators
   a. Comply with Section 15078.
2.02 BALL VALVE (BV-#)

A. BV-1
1. Size: ¼ inch to 3 inch
2. Body: Forged brass
3. Ball: Chrome plated brass
4. Stem: Nickel plated brass
5. Seat: Virgin PTFE
6. End Connections:
   a. Threaded up to 3 inch
   b. Soldered up to 2 inch
7. Actuator:
   a. Provide type as specified in the attached valve schedule.
   b. One-quarter turn to open or close.
8. Manufacturers
   a. Jamesbury, Series 300
   b. Or equal

B. BV-2
1. Size: ½ inch to 4 inch true union PVC ball valves
2. Design Standard
   a. ASTM D2467
   b. NSF 61
3. Body, ball and stem:
   a. PVC conforming to ASTM D1784, Classification 12454-B
4. Seat:
   a. Teflon
5. End Connections:
   a. True union
   b. Socket
   c. Flanged
6. Actuator:
   a. Provide type as specified in the attached valve schedule.
   b. One-quarter turn to open or close.
7. Manufacturers
   a. Asahi
   b. Hayward
   c. Or Equal
2.03 BUTTERFLY VALVE (BFV-#)

A. General
   1. Suitable for throttling operations and long periods of infrequent operation.
   2. Do not use internal travel stops.
   3. Provide bubble tight shut-off with rated pressure on either side of the valve disc.
   4. Connect operators to valve shafts using keys and keyways.

B. BFV-1
   1. Size: 4 inch and larger resilient seated butterfly valves.
   2. Design Standard:
      a. AWWA C504
      b. NSF 61
   3. Body:
      a. Class 150B
      b. Flanged, short style
      c. Cast iron conforming to ASTM A126 or ductile iron conforming to ASTM A536
   4. Disc:
      a. Cast iron conforming to ASTM A126, Class B
      b. Ductile iron conforming to ASTM A536, Grade 65-45-12.
   5. Stem:
      a. Type 304 or 316 stainless steel conforming to ASTM A276.
      b. One or two piece construction.
      c. Secure to disk using stainless steel taper pins and hardware. Design to prevent leakage at pins.
      d. Stem seals
         (1) O-rings
         (2) Self adjusting, wear compensating V-type packing.
   6. Seat:
      a. Buna-N
      b. Retain in valve body or secure to disk.
         (1) Use stainless steel hardware and corrosion resistant retaining ring if seat is secured to the disk.
         (2) If seat is bonded to the body, comply with ASTM D429, Method B with minimum 75-pound pull.
         (3) Design seat to be both adjustable and replaceable in the field.
      c. Provide continuous 360-degree seal. Do not penetrate seat with stem.
   7. End Connections:
      a. Flanged
(1) Conform to ANSI B16.1
(2) Full faced

b. Mechanical Joint
(1) Conform to ANSI A21.11/AWWA C111

8. Bearings:
   a. Self lubricating
   b. Corrosion resistant, non-metallic

9. Actuator:
   a. Comply with AWWA C504
   b. Design to hold valve in any position without creeping or fluttering.
   c. Provide type as specified in the attached valve schedule.

10. Coatings and Linings:
    a. Conform to AWWA C504.
    b. Prime coat interior of valves.
       (1) Comply with Section 09900
       (2) Ensure primer is compatible with specified field coatings.
    c. NSF 61 compliant

11. Manufacturer:
    a. Val-Matic
    b. M&H
    c. Or Equal

C. BFV-2
1. Butterfly Valves for HVAC and Plumbing Lines
2. Butterfly valves to be 150 psi water oil gas (WOG) pressure-rated-full-lug pattern, with tapped lugs and resilient seat giving bubble-tight shutoff at temperatures up to 250 degrees F, for the indicated service. The body to be cast iron or semi-steel, and the seat and shaft seals to be reinforced TFE. The disc to be of bronze or aluminum bronze. Butterfly valves in insulated lines to be provided with extended necks to clear the insulation.
3. Butterfly valves 6-inches and smaller to be provided with infinite adjustment lever handles and locking devices. Valves 8-inches and larger to be provided with a gear operator. An indication of valve position to be included, evident from a normal standing position. Butterfly valves to be installed by bolting separately to each pipe mating flange.
4. Manufacturer:
   a. DeZurik
   b. Keystone
   c. Or Equal
2.04 GATE VALVE (GV-#)
A. GV-1
   1. Size: less than 3-inch
   2. Design Standard: MSS SP-80
   3. Body and bonnet: Cast Bronze conforming to ASTM B62
   4. Gate Disc:
      a. Solid wedge
      b. Bronze conforming to ASTM B62
   5. Stem:
      a. Rising stem
      b. Brass or bronze alloy conforming to ASTM B371 or B99
      c. Dezincification resistant
   6. Packing:
      a. Compliant with NSF61.
      b. Do not use asbestos rope packing.
      c. HVAC and plumbing gate valves shall have Teflon impregnated packing.
   7. End Connections:
      a. Threaded conforming to ANSI B1.20.1
      b. Soldered conforming to ANSI B16.18. Do not use soldered connections for hot water service.
   8. Actuator:
      a. Manual handwheel
      b. Attached to valve stem
      c. Malleable iron construction
   9. Manufacturer
      a. Watts Regulator Company
      b. NIBCO
      c. Powell
      d. Or Equal

2.05 PLUG VALVES (PGV-#)
A. PGV-1
   1. Non-Lubricated, Eccentric Type
   2. Port area:
      a. 24-inch and smaller: minimum of 80 percent of full pipe area.
      b. Larger than 24-inch: minimum of 70 percent of full pipe area.
   3. Design Standard:
      a. ANSI B16.1
4. Body:
   a. Cast iron conforming to ASTM A126, Class B.
   b. Ductile iron conforming to ASTM A536.
   c. Cast with raised eccentric seats which have corrosion resistant welded-in overlay of not less than 90 percent pure nickel on all surfaces contacting the plug face.
   d. Valve seats to be in accordance with AWWA C504 and AWWA C507, latest revisions.

5. Plug: resilient faced plugs with Neoprene or Buna-N facing.

6. Bearings:
   a. Stainless steel
   b. Permanently lubricated
   c. Sleeve-type Stem:

7. Packing: Buna-Vee type, “Chevron” style design

8. Nuts, Bolts, Springs, Washers, etc.:
   a. Type 316 stainless steel.
   b. Treat nuts and bolts with Molykote P37 as manufactured by Dow Corning, or equal.


10. Actuator:
    a. Provide type as specified in valve schedule.
    b. Include geared operator, valve box and extended operating nut.
    c. One-quarter turn to open or close.

11. Coatings and Linings:
    a. Interior Valve Lining:
       (1) With exception of valve seating surfaces, coat all interior ferrous surfaces with a factory applied, fusion bonded or thermosetting polyurethane or PVC bond coating in accordance with AWWA C550, latest revision.
       (2) Coating to be holiday-free with a minimum thickness of 12 mils.
       (3) Surfaces to be clean, dry and free from rust, oil, and grease before coating.
    b. Exterior Valve Coating: Coat the valve in accordance with Section 09900.

12. Manufacturer:
    a. Val-Matic
    b. DeZurik
c. or Equal

B. Lubricated Plug Valves (PGV-2)

1. Semi-steel
2. Designed for operating pressures of not less than 125 pounds steam or 200 pounds water, oil, or gas.
3. Port opening areas shall be not less than 80 percent of the pipe area.
4. Plugs to be rotated 90 degrees from full open to full shut and provided with stops.
5. Valves to be designed so that excessive lubricant pressure cannot be built up and that lubricant cannot be forced into the pipeline.
6. Lubrication to be through Alemite fittings on the body of the valve.
7. Sealing at the operating end of the plug to be accomplished by means of a Teflon gasket held in leakproof contact between the plug and body, by means of a coil spring at the base of the plug, or by means of resilient packing and a bolted gland or plastic packing applied under pressure.
8. If resilient or plastic packing is used, the packing must be replaceable while the valve is under pressure.
9. Lubricants to be suitable for use with the material handled through the valve.
10. Provide not less than two pounds of lubricant for each valve after the initial lubrication has been made.
11. Lubricated plug valves 6-inch and smaller to be wrench-operated and valves 8-inch and larger to be gear-operated, unless otherwise shown. One wrench is to be furnished for each size of valve in each individual room or operation space in which valves are located.

2.06 DIAPHRAGM VALVE (DPV-#)

A. DPV-1

1. Type: PVC weir type diaphragm valve
2. Size: 4 inch
3. Body and Bonnet
   a. Molded of solid thermoplastic.
   b. PVC conforming to ASTM D1784, Type I, cell classification 12454-A
   c. CPVC conforming to ASTM D1784, Type IV, cell classification 23447.
4. Diaphragm: EPDM backed Teflon
5. Stem: Stainless Steel with adjustable position indicator.
6. End Connections:
   a. Flanged
   b. Conforming to ANSI B16.5
7. Actuator: Provide the type indicated in the attached valve schedule.
8. Manufacturers
   a. Asahi
   b. Hayward
2.07 CHECK VALVE (CV-#)

A. General
   1. Provide limit switches where shown on the Drawings.

B. CV-1
   1. Type: Swing check valve for water service
   2. Size: 2 1/2-inches and smaller
   3. Design Standard: MSS SP-80
   4. Body:
      a. Wye pattern
      b. Swing type
      c. Bronze construction conforming to ASTM B62
   5. Disc: Bronze conforming to ASTM B62
   6. Seat Disc: Buna-N
   7. End Connections:
      a. Threaded conforming to ANSI B1.20.1
      b. Soldered conforming to ANSI B16.18
   8. Manufacturers:
      a. Watts Regulator Company
      b. NIBCO
      c. Or Equal

C. CV-2
   1. Type: Swing check valve with outside lever and weight for water service
   2. Size: 4 inches to 30 inches
   3. Design Standard:
      a. AWWA C508
      b. NSF 61
   4. Body:
      a. Cast iron conforming to ASTM A126, Class B
      b. Ductile iron conforming to ASTM A536.
      c. Design to permit top entry for removal of internal components without removing valve from pipeline.
   5. Disc:
      a. Construct of rubber-faced cast iron.
      b. Does not restrict flow path when fully open.
      c. Provide outside lever and weight to minimize slamming.
6. **Hinge Pins:**
   a. 18-8 stainless steel rotating bronze plugs
   b. Key for counterweight arm.

7. **End Connections:**
   a. Flanged
   b. Comply with ANSI B16.1, Class 125

8. **Manufacturers:**
   a. M&H Valve Company
   b. Clow
   c. Or Equal

D. **CV-3**

1. **Type:** Double-door check valve for water service
2. **Size:** 2 inches to 12 inches
3. **Design Standard:**
   a. ANSI/API 594
   b. NSF 61
4. **Body:**
   a. Cast iron conforming to ASTM A126, Class B
   b. Ductile iron conforming to ASTM A536, Grade 65-45-12.
   c. Buna-N seat.
   d. Include steel eye bolt for lifting valve.
5. **Doors:**
6. **Hinge Pins:**
   a. T316 stainless steel conforming to ASTM A276

7. **Torsion Spring:**
   a. T316 stainless steel conforming to ASTM A313

8. **End Connections:**
   a. Wafer-type
   b. Flat-faced
   c. Class 125

9. **Manufacturers:**
   a. Valve and Primer Corporation
   b. Val-Matic
   c. Or Equal
2.08 GLOBE VALVE (GLV-#)

A. GLV-1

1. Design Standard: MSS SP-80  
2. Size: 3-inches and smaller  
4. Union Bonnet: Bronze ASTM B 62  
5. Disc: TEFC  
6. Inside screw  
7. Rising stem  
8. Packing: Teflon, impregnated  
9. Rated for 150 pounds

2.09 MISCELLANEOUS VALVES

A. Globe Bodied Pump Control Valve (PCV-#)

1. PCV-1

   a. Solenoid-operated, flanged-bodied, hydraulically actuated, globe-pattern valve with two separate sealed chambers. Mechanical lift-check feature to close valve and prevent reverse flow when flow stops. Two-piece telescoping disc and diaphragm assembly shall be guided by two separate bearings. Valve and pump operators shall be interlocked by a limit switch assembly. Adjustable opening and closing speeds.

   b. Main valve body and cover materials - ASTM A536 ductile iron with Type 316 stainless steel trim and throttling components

   c. Disc and diaphragm assembly materials – Nylon-reinforced Buna-N disc

   d. Cv of 1,200 gallons per minute (gpm) for 10-inch PCV-1

   e. Pilot control system shall contain a three-way solenoid pilot, two three-way accelerator pilots, single limit switch, separate adjustable opening and closing speed controls, two check valves, two Y-strainers, and isolation ball valves on all body connections.

   f. Pilot control system materials – Copper tubing and brass fittings

   g. Lining and coating – NSF-listed, fusion-bonded epoxy

   h. Manufacturer

      (1) Valve

         (A) Watts ACV Model M513-AK

         (B) Approved equal

B. Chemical Injector (CI#)

1. CI-1

   a. Retractable injection quill with restraint

   b. Size: ¾-inch stainless steel ball valve

   c. Compression hardware: stainless steel

   d. Safety chain: stainless steel
e. Solution tube: 3/8-inch PVC, 6-inch insertion length
f. Flexible hose assembly
g. Tip configuration:
   (1) SAF-T-SEAL (EPDM) for lime and polymer
   (2) SAF-T-SEAL (Viton) for NaOCl
h. Check valve: spring-loaded
i. Manufacturer:
   (1) Saf-T-Flo or approved equal

2.10 ACCESSORIES

A. Floor Boxes
   1. Provide for each valve shown on the Drawings with an extended operating nut.
      a. Mount flush with the top of the slab and make the length of the box equal to the slab thickness.
      b. Use bushing type to support stem at the floor and preserve stem alignment.
      c. Include cover to protect the operating nut.
   2. Manufacturer:
      a. Clow
      b. Or equal

B. Floor Stands
   1. Cast iron construction.
   2. Design for handwheel operator, gear operator or motor operator as shown on the Drawings. Provide floor stand bracket where necessary to locate floor stand where shown on the Drawings.
   3. Use indicating type for non-rising stem applications. Provide clear stem covers with graduations to show valve position for rising stem applications.
   4. Manufacturer:
      a. Clow
      b. Mueller
      c. Or equal

C. Extension Stems and Guides
   1. Size for the maximum valve torque.
   2. Use stem guides to limit the stem L/R ratio to less than or equal to 200.
      a. Cast iron construction.
      b. Bronze bushed at the stem support.
      c. Adjustable in two directions at right angles in a plane perpendicular to the stem.
      d. Secure with 304 stainless steel angle bolts.
      e. Manufacturer
D. Chainwheel Operators
   1. Provide galvanized or cadmium plates wheels, guides and chains.
   2. Include chain guides to prevent the chain from slipping off of the wheel.
   3. Size chain as recommended by the valve manufacturer.
   4. Provided by the valve manufacturer.

PART 3 EXECUTION
3.01 INSTALLATION
A. Install all valves and appurtenances in accordance with the manufacturer’s instructions, referenced AWWA standards and the Contract Documents.
B. Close valve ends using caps, plugs or wooden flange covers to prevent dirt, building materials or other foreign matter from entering.
C. Leave no more than two threads exposed on a completed threaded connection. Use Teflon tape joint sealer when making the connection.
D. Install plug valves and butterfly valves such that the valve operating stem is horizontal and the seat is as shown on the Drawings.
   1. If no seat position is shown, flow shall produce a seating pressure.
   2. Make the plug open toward the highest portion of the valve.
E. Support all valves as shown on the Drawings and in accordance with Sections 15050 and 15140.
F. Locate valves such that they are readily accessible for maintenance. Provide access doors in finished walls or enclosed ceilings.
G. Provide a line size ball valve or gate valve upstream of each solenoid valve, in-line flow switch or similar control device. Use the same construction materials as the connecting pipeline.
H. Valve Boxes
   1. Provide for each buried valve.
      a. Provide concrete support pad beneath each buried valve.
      b. Exercise the valve to ensure it is in proper working order. Notify the Engineer of problems.
      c. Backfill and compact at the valve box to ensure no vertical loads are transmitted to the operator or the valve bonnet.
   2. Set valve box at right angles to the pipe.
      a. Center and plumb the box over the valve operating nut.
      b. Make the box cover flush with finished grade.
   3. Extend the operating nut to within 12 inches of grade.
   4. Support the extension stem as required to maintain the operating nut in position.
3.02  FIELD PAINTING
   A.  Field prepare and paint required surfaces as specified in Section 09900.

3.03  FIELD QUALITY CONTROL AND TESTING
   A.  Perform field inspection and testing in accordance with Section 01650.

END OF SECTION
SECTON 15077
SELF-CONTAINED AUTOMATIC VALVES

PART 1 GENERAL

1.01 DESCRIPTION

A. Provide self-contained automatic valves and appurtenances as specified and as shown on the Contract Documents. The valves contained in this section include, but are not necessarily limited to, the following:
   1. Pump control valves
   2. Pressure-reducing valves
   3. Pressure safety valves
   4. Solenoid valves

1.02 QUALITY ASSURANCE

A. Comply with applicable portions of Sections General Provisions and 15050.
B. Provide components that are the standard product of a manufacturer regularly engaged in the production of the required materials and equipment.
   1. Use a single manufacturer to provide all valves of the same type.
   2. Ensure that parts for valves of the same size and type are interchangeable.
C. Comply with applicable standards including, but not limited to the most recent edition of the following:
   1. American National Standards Institute (ANSI)
   3. American Water Works Associations (AWWA)
D. Design to provide satisfactory performance under the specified operating conditions.

1.03 SUBMITTALS

A. Comply with Section SP-09. Identify each valve using the appropriate valve identifier and the tag number shown on the process and instrumentation diagram (P&ID). Include the following information with the submittal:
   1. Manufacturer’s catalog and product information that describes each type of valve provided. Include
      a. Specifications.
      b. A complete bill of materials that identifies all materials of construction.
      c. Preventive/corrective maintenance instructions.
      d. Certification of seat/valve compatibility with the expected process fluid.
      e. Flow performance charts.
      f. Special shipping, storage, protection, and handling instructions.
   2. Shop Drawings. Submit separate shop drawings for each type of valve provided. Include:
      a. Layout drawings
      b. Complete nameplate data.
B. Submit compliance certificates for specified tests and design standards.

C. Submit Operation and Maintenance Manuals in accordance with Section SP-10. Also include the following:

1. A list of manufacturer’s recommended parts required to maintain the equipment for a period of one year, with current price information.
2. A list of special tools, materials, and supplies furnished with the equipment for use prior to and during startup, and for future maintenance.
3. Manufacturer’s installation instructions.
4. Troubleshooting guide.
5. Detailed operating description for control valves and valves used in modulating service. Identify both normal and limiting operating characteristics.

D. Submit manufacturer’s certificates in accordance with the Sections SP-08.

1.04 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Deliver, handle, and store the equipment in accordance with Section SP-14 and this specification.

B. Handle and store components so as to prevent damage.

1. Protect finishes, coatings, and appurtenances.
2. Store valves off the ground and protect against dirt, moisture or foreign material entering the ends.
3. Protect polyvinyl chloride (PVC) and chlorinated polyvinyl chloride (CPVC) valves against ultraviolet (UV) degradation. As a minimum, cover with an opaque material.
4. Store gaskets in original containers and wrappers; and store in a cool, well ventilated area that is protected from the direct rays of the sun. Do not allow contact with oils, fats, or petroleum solvents.

1.05 SPECIALTOOLS AND SPARE PARTS

A. Provide spare parts as recommended by the manufacturer in their O&M Manual.

B. Furnish one complete set of special tools required to disassemble, service, repair, and adjust the equipment.

PART 2 PRODUCTS

2.01 GENERAL

A. General Valve Requirements

1. Select such that it is suitable for the intended service. Provide certificate from an accredited certification organization that the product is suitable for contact with drinking water in accordance with ANSI/NSF Standard 61.

2. Use the following in metal pipelines unless otherwise shown on the Drawings:

a. Two inch diameter and smaller:
   (1) All brass or bronze except for external components.
   (2) Screwed or soldered ends.

b. Two and one-half inches in diameter and larger
   (1) Iron body, bronze mounted
(2) Flanged or mechanical joint ends for valves 4-inches in diameter and larger.

(3) Screwed connections may be used for smaller valves.

3. Make valve the same size as connecting piping. Drawings indicate nominal size unless otherwise noted.

4. Provide end connections that are compatible with connecting piping. See Section 15075 for piping requirements.
   a. Cast flanges and mechanical joint bells at right angles to the casting axis.
   b. Drill and shop coat with a rust preventive compound prior to shipment.
   c. Provide a union adjacent to all valves with screwed or soldered connections to facilitate removal.

5. Open counter-clockwise.

6. Provide the manufacturer’s name and valve size on the body or bonnet of the valve. Use
   a. Cast letters, or
   b. Provide permanently attached plate with information stamped in raised letters.

2.02 PUMP CONTROL VALVES (PCV-#)
A. PCV-1

1. Type: Pilot-operated diaphragm valve designed to minimize the surges associated with the starting and stopping of pumps. Valve shall be designed to open at an adjustable rate upon pump start-up and close at an adjustable rate upon pump shut-off. When the valve is nearly closed, the limit switch shall be tripped, turning the pump off. The pump shall start and stop against a closed valve. The valve shall have provisions for manual operation in the event of power outage. Solenoid valve shall be 3-way, as specified herein. Enclosure shall be NEMA 4X.

2. Size: 2-inch to 16-inch

3. Main valve body and cover
   a. Globe style
   b. ASTM A536 ductile iron
   c. Ductile iron components shall be lined and coated with an NSF-61-certified epoxy coating. Coating shall be applied by the electrostatic heat fusion process.

4. Main valve trim and throttling (cover bearing, power chamber bearing, valve seat and disc guide) components
   a. Stainless steel
   b. Valve body, cover, and power chamber shall be machined with a 360-degree locating lip to assure proper alignment.

5. Disc and diaphragm assembly
   a. Two separate sealed chambers
   b. Diaphragm shall be constructed of nylon-reinforced, Buna-N.
c. Buna-N synthetic rubber disc with a rectangular cross-section that is securely retained on 3-1/2 sides by a disc retainer and disc guide.
d. Disc and diaphragm assembly shall be guided by two separate bearings, one installed in the valve cover and one concentrically located within the power chamber, to avoid deflection and assure positive disc-to-seat contact.

6. Pilot control system
a. Pilot control system shall utilize the highest source of available pressure (upstream or downstream) to operate the valve.
b. Pilot control system shall contain a 3-way solenoid pilot with screw-type manual operator; two, 3-way accelerator pilots; single limit switch; separate, adjustable opening- and closing-speed controls; two check valves; two Y-strainers and isolation ball valves and all body connections.
c. Copper tubing and brass fittings

7. Manufacturers
a. Watts ACV Model M513-AK
b. Cla-Val Model 60-11
c. Or equal

2.03 PRESSURE-REDUCING VALVES (PRV-#)
A. PRV-1
1. Type: Hydraulically operated, diaphragm actuated type designed to deliver a constant downstream pressure with flow and/or upstream supply pressure fluctuating.
2. Size: 1-1/4 inch to 24 inch
3. Body and Cover
   a. Globe style
   b. Ductile iron conforming to ASTM A536
4. Seat:
   a. Replaceable
   b. AISI 316 Stainless Steel
5. Trim: Stainless Steel
6. Diaphragm:
   a. Nylon reinforced Buna-N
   b. Withstand Mullins Burst Test of a minimum of 600 psi per layer of nylon fabric.
   c. Withstand cycle testing of 100,000 cycles to ensure longevity.
7. Disc: Buna-N
8. End Connections:
   a. Flanged
   b. ANSI Class 125
9. Coatings and Linings  
   a. Fusion bonded epoxy inside and outside  
   b. Conform to AWWA C550  

10. Flow and Pressure Ratings:  
    a. See PRV schedule in Drawings.  

11. Manufacturers  
    a. Watts Regulator, Model 115  
    b. Cla-Val, Model 90-01  
    c. Or Equal  

2.04 SOLENOID VALVE (FV-#)  
   A. SV-1  
   1. Type: Packless 2-way, 3-way or 4-way solenoid valve as required by the application.  
   2. Size: As required by the application or as scheduled  
   3. Design Standard  
      a. UL and FM approved  
   4. Body: Forged brass  
   5. Internals: Stainless steel  
   6. Seals and Discs:  
      a. EPDM for hot water service  
      b. PTFE  
      c. Or as recommended by the manufacturer for the application.  
   7. Solenoid  
      a. Coil  
         (1) Design for either intermittent or continuous duty  
         (2) Power supply: 120 volt, AC; 60 Hertz  
         (3) Rate for continuous operation at 110 percent of rated voltage  
      b. Housing  
         (1) NEMA 4X for non-hazardous locations.  
         (2) NEMA 7/NEMA 4X in hazardous areas.  
   8. End Connections:  
      a. Threaded conforming to ANSI B1.20.1  
   9. Manufacturers  
      a. ASCO Red-Hat II  
      b. Or Equal
PART 3 EXECUTION

3.01 INSTALLATION
   A. Install all valves and appurtenances in accordance with the manufacturer’s instructions and the Contract Documents.
   B. Comply with applicable provisions of Section 15076.

3.02 FIELD QUALITY CONTROL AND TESTING
   A. Perform field inspection and testing in accordance with Section 01650.

END OF SECTION
PART 1 GENERAL

1.01 DESCRIPTION
A. This section includes the requirements for motorized and pneumatic valve actuators with appurtenances as specified and as shown on the Contract Documents.

1.02 QUALITY ASSURANCE
A. Provide components that are the standard product of a manufacturer regularly engaged in the production of the required materials and equipment.
   1. The valve manufacturer shall select the actuator and install to meet the specified operating requirements.
   2. The valve manufacturer shall be responsible for the proper operation of all components.
B. Comply with applicable standards including, but not limited to, the most recent edition of the following:
   1. American Water Works Association (AWWA)
      a. C504: Rubber-Seated Butterfly Valves
      b. C517: Resilient-Seated Cast-Iron Eccentric Plug Valves
      c. C540: Power-Actuating Devices for Valves and Slide Gates
C. Design to provide satisfactory performance under the specified operating conditions.

1.03 SUBMITTALS
A. Identify each valve actuator using the appropriate valve actuator identifier and the valve tag numbers shown on the P&ID. Include the following information with the submittal:
   1. Manufacturer’s catalog and product information that describes each type of valve actuator provided. Include
      a. Specifications.
      b. A complete bill of materials that identifies all materials of construction.
      c. Preventive/corrective maintenance instructions.
      d. Actuator dimensions and weights.
      e. Actuator sizing calculations.
      f. Special shipping, storage, protection, and handling instructions.
   2. Shop Drawings. Submit separate shop drawings in accordance with SP-09, for each type of valve provided. Include:
      a. Layout drawings
      b. Control schematics.
      c. Power and wiring diagrams with terminal numbers. Include:
         (1) Motor currents at the specified voltage corresponding to locked rotor.
         (2) Maximum seating torque.
(3) Average running load and speed.
   d. Complete nameplate data.

B. Submit compliance certificates for specified tests and design standards in accordance with SP-05.

C. Submit Operation and Maintenance Manuals in accordance with SP-10. Include:
   1. A list of manufacturer’s recommended parts required to maintain the equipment for a period of one year, with current price information.
   2. A list of special tools, materials, and supplies furnished with the equipment for use prior to and during startup, and for future maintenance.
   3. Manufacturer’s installation instructions.
   4. Troubleshooting guide.

D. Submit manufacturer’s certificates in accordance with the Section SP-06.

1.04 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Deliver, handle, and store the equipment in accordance with Section SP-14 and this specification.

B. Handle and store components so as to prevent damage.
   1. Protect finishes, coatings, and appurtenances.
   2. Store valves and actuators off the ground and protect against dirt, moisture or foreign material entering the ends.

1.05 SPECIAL TOOLS AND SPARE PARTS

A. Provide spare parts recommended by the manufacturer. At a minimum, provide the following spare parts:
   1. One of each size and type of fuse required.

B. Furnish one complete set of special tools required to disassemble, service, repair, and adjust the equipment.

PART 2 PRODUCTS

2.01 GENERAL

A. Valves are specified in Section 15076 by both type and style. Each style within a particular type of valve is assigned a unique identifier.
   1. As an example, butterfly valves are identified as BFV-1, BFV-2, etc.
   2. The type and style of valve to be used for each application is indicated on the Drawings using the appropriate valve identifier.

B. Select each actuator such that it is suitable for the intended service, including the environment and the area classification.

C. Actuators shall be sized, furnished, and installed by the valve manufacturer who will be solely responsible for proper operation of the assembly.
   1. Mount actuators to the valve in the factory.
   2. Ship the actuator and valve as a completed assembly.

D. Use actuators by a single manufacturer wherever possible for all valves that are the same type and style.
2.02 ELECTRIC ACTUATORS

A. General

1. Provide electric actuators for those valves identified as being motor operated on the Drawings.

2. Actuator sizing

   a. Suitable for operation on 480 volt, 3-phase, 60 hertz power supply.
   b. Open counter-clockwise.
   c. Size to bring the valve from a fully open to a fully closed position (or vice versa) against full line pressure in 60 seconds or less.
   d. Hold the valve in all intermediate positions without vibration.
   e. Ensure torque switch trip at maximum torque with supply voltage 10% below nominal.

3. Comply with AWWA C540.

4. Design outdoor actuators for an ambient temperature range of -20 degrees F to +140 degrees F and up to 100-percent relative humidity.

5. Certify that actuators installed in explosive or hazardous atmospheres are Flameproof for Zones 1 and 2.

6. Provide actuators that are suitable for both local and remote control as shown on the P&IDs.

B. Quarter-turn or Multi-turn actuators (Type E1)

1. Use close-coupled, electric-motor driven, worm-gear type. Include:

   a. Gear Drive
   b. Motor
   c. Controls
   d. Appurtenances

2. Gear Drive

   a. Cast iron or ductile iron housing.
   b. Suitable for intended service.
   c. Double gear reduction using worm gear and either spur or helical gearing.
      (1) Construct worm gear of alloy bronze or steel.
      (2) Construct spur or helical gearing of heat treated steel.
      (3) Do not use non-metallic gears.
   d. Lubricate by packing in grease or using an oil bath. Use food-grade lubricants.
   e. Support gearing and shafting on anti-friction bearings. Use tapered roller bearings to support thrust components.
   f. Design such that the gear case may be removed for inspection or may be disassembled, without taking the valve out of service.
g. Provide reversing starter, control transformer and local controls integral with the valve actuator.
   (1) House to prevent breathing and condensation.
   (2) Size starter for start/stop applications for at least 60 starts per hour.
   (3) Size starter for modulating service for at least 1,200 starts per hour.

3. Motor
   a. Comply with Section 16051.
   b. Provide a high torque, TENV, ball or roller bearing, squirrel-cage-type motor, designed specifically for valve actuator service.
      (1) Class F insulation or better
      (2) Provide time rating of at least 15 minutes at 104 degrees F or twice the valve opening/closing time, whichever is longer.
      (3) Include thermal overload protection.
   c. Transmit power using splined connections. Do not use keys.
   d. Design such that electrical and mechanical disconnects are possible without draining lubricant from the actuator gear case.
   e. Provide loss of phase protection and include internal protection to de-energize the motor in the event of a stall when attempting to unseat a jammed valve.

4. Controls
   a. NEMA 4 enclosure
      (1) Provide an inner watertight and dustproof O-ring seal between the terminal compartment and the internal electrical elements.
      (2) Use stainless steel external fasteners.
      (3) Include thermostatically controlled space heaters for outdoor units to prevent condensation. Provide heaters in both the operator and the control compartments.
   b. Provide local controls to open, close and stop valve operation.
      (1) Include local/stop/remote mode selector switch that is lockable in any of the three positions.
      (2) When in the remote position, respond to the control signal shown on the Drawings. Remain in the last position if the signal is lost.
      (3) Interlock to prevent simultaneous local and remote valve control.
      (4) Arrange controls so that the valve travel direction can be reversed without requiring that the actuator be stopped.
   c. Provide for handwheel operation in an emergency.
      (1) Make handwheel drive mechanically independent of the motor drive. Size gearing to operate valve in a reasonable time.
(2) De-clutch motor using a lever or similar device to allow handwheel operation. Include provisions to lock in both hand and auto positions.

(3) Automatically restore drive to power operation by starting the motor.

(4) Do not move the handwheel or the selection lever upon restoring the motor drive.

d. Provide adjustable “torque” and “turns” limitations.

(1) Interrupt the motor power circuit if an obstruction is encountered in either direction of travel or when torque seating of valve is required for tight shut-off.

(2) Inhibit torque overload during unseating or during starting in mid travel against high inertia loads.

(3) Make mechanical torque springs “field replaceable”.

e. Position indication

(1) Display position both locally and remotely.

(2) Provide green and red indicating lights for valve position. Green indicates Open, and Red indicates Closed.

(3) Provide digital position indicator locally to show valve position in 1% increments. Include 4-20 mA transmitter for remote indication of valve position.

(4) Maintain and update valve position during manual operation.

f. Valve status

(1) Display status both locally and remotely.

(2) Provide four normally open contacts. Two will indicate valve position and the remaining two will indicate valve failure and the use of remote operation.

5. Appurtenances

a. Provide additional limit switches, indicating lights, position transmitters, remote controls and accessories as shown on the Contract Documents.

C. Manufacturers

1. Kinetrol
2. Limitorque Series MX
3. Rotork Model Q, AQ, A, or IQ.
4. Or equal

2.03 PNEUMATIC ACTUATORS

A. General

1. Provide pneumatic actuators for those valves identified on the Drawings.

2. Actuator sizing

   a. Supply air pressure shall be 80 to 100 PSIG.

   b. Open counter-clockwise.
c. Size to bring the valve from a fully open to a fully closed position (or vice versa) against full line pressure in 60 seconds or less.

d. Hold the valve in all intermediate positions without vibration.

3. Comply with AWWA C540-02.

4. Design outdoor actuators for an ambient temperature range of -20 degrees F to +140 degrees F and up to 100 percent relative humidity.

5. Certify that actuators installed in explosive or hazardous atmospheres are Flameproof for Zones 1 and 2.

6. Provide actuators that are suitable for both local and remote control as shown on the P&IDs.

B. Rotary Vane actuators

1. The actuators shall be rated for severe duty and sized to handle the pressure, torque and closure time requirements of the limit switch installation.

2. Provide each valve with integral NAMUR interface for limit switch installation.

3. Provide each valve with integral NAMUR mounted limit switch to indicate locally the valve open-close position and provide a digital output for remote monitoring of the valve open-close status.

4. All actuators located not greater than 5-feet above the floor or other type of access platform shall be provided with NAMUR mounted solenoid valves switches for controlling the valve open/ close process.

5. Solenoid valves shall include manual overrides to permit manual opening and closing of the valve in the event that power to the solenoid valve is not available.

6. Solenoid valves shall be selected to fail in the position required by the vendor in the event of a power failure to prevent flooding or other catastrophic damage.

7. For actuators which are located higher than 5-feet above the floor or access platform, they shall be provided with a remote mounted solenoid valve suitable for mounting on a backboard.

C. Manufacturers

1. Kinetrol

2. Or equal

2.04 SHOP PAINTING

A. Comply with AWWA C540.

B. Provide epoxy coating system for maximum corrosion protection.

PART 3 EXECUTION

3.01 SHOP TESTING

A. Conduct proof of design and performance tests as specified in AWWA C540.

B. Provide individual test certificates and test reports.

3.02 INSTALLATION

A. The valve manufacturer shall install the actuators prior to shipping the completed assembly to the project site.

B. Install the actuators and appurtenances in accordance with the manufacturer’s instructions and the Contract Documents.
3.03 FIELD QUALITY CONTROL AND TESTING
   A. Inspect and test all installed components in accordance with Section 01650.

3.04 MANUFACTURER’S FIELD SERVICES
   A. Provide manufacturer’s field services.
      1. Include at least two-8 hour days for the actuator manufacturer to perform the following:
         a. Inspect, test, calibrate, and adjust all equipment, accessories and controls.
         b. Certify that each installation is complete and ready for operation.
   B. Training
      1. Provide at least two – 8 hour days to instruct representatives of the Owner and Engineer.
      2. Include the following as part of the instruction:
         a. General electrical, mechanical, operational and maintenance requirements of each type actuator.
         b. Actuator interface with the communications network.
         c. Programming and troubleshooting.

END OF SECTION
SECTION 15140
HANGERS AND SUPPORTS

PART 1 GENERAL

1.01 DESCRIPTION

A. Provide supports, hangers and anchors for piping, ductwork, valves, dampers, and miscellaneous equipment as specified.

B. Pipe support systems shall be designed by the Contractor. The Contract Drawings depict only typical pipe support details, as well as any locations where specific support types may be required. Adequate pipe supports shall be supplied for all systems to provide a rigid overall installation and additional support for pipe ends when equipment is disconnected.

1.02 QUALITY ASSURANCE

A. Comply with all applicable portions of section 15050.

B. Provide components that are the standard product of a manufacturer regularly engaged in the production of the required materials and equipment.

1. A single manufacturer shall provide all hangers and supports and appurtenances.

2. The manufacturer shall be responsible for the design, construction and proper operation of all components.

C. Factor of Safety

1. Hangers and supporting devices shall be designed to provide a minimum working safety factor of 12.

2. The safety factor for pipe hangers and supports shall be based on supporting ten linear feet of pipe filled with water.

3. The safety factor for ductwork supports shall be based on the weight of the ductwork and the duct containing a buildup of material equal to ten percent of the cross-sectional area with a material at 60 pounds per cubic foot.

D. Comply with applicable standards including, but not limited to the most recent edition of the following:

1. Manufacturers Standardization Society SP-58, 69.


E. Design to provide satisfactory performance under the specified operating conditions.

1.03 SUBMITTALS

A. Comply with Section SP-09. Include the following information:

1. Make, model and design performance of each hanger and support and appurtenances.

2. Details of methods for attachment of hangers and supports to building construction for equipment and piping.

3. Manufacturer’s catalog information that describes each type of hanger and support provided. Include:

   a. Specifications

   b. A complete bill of materials that identifies all materials of construction.
4. Sizing calculations for each type of hanger and support provided.
   a. Demonstrate acceptable performance for specified operating conditions.
   b. Size each hanger and support
5. Certified structural, mechanical, electrical, and erection drawings. Show:
   a. Important details of construction,
   b. Equipment dimensions,
   c. Size and location of anchor bolts, and
   d. Locations of connections to other work.
6. Special shipping, storage, protection, and handling instructions.
7. Manufacturer’s installation instructions.

PART 2 MATERIALS

2.01 ACCEPTABLE MANUFACTURERS
   A. ITT Grinnell Corp
   B. B-Line Systems
   C. Equal

2.02 PIPE HANGERS AND SUPPORTS
   A. Pipe hangers and supports provided shall be of quality as specified herein.
   B. Any reference to a specific figure number of a specific manufacturer is for the purpose of
      establishing a type and quality of product and shall not be considered proprietary.
   C. Supporting devices shall be devised in accordance with the best practice and the
      required strength of the supporting devices shall be based on the combined weight of the
      piping and connected equipment, filled with liquid and insulated where applicable.
   D. All supporting devices shall be designed to minimize interference with access and
      movement. The injury hazard shall be considered and shall be eliminated in all protruding
      supporting devices.
   E. Pipe Support components for the details that follow are to establish levels of duty and
      quality. These Pipe Support details are shown on Contract Drawings.
   1. Detail 1: Pipe Support – Stanchion at Flange for 3-inch to 24-inch pipe
      a. Fabricated steel – hot-dip galvanized after fabrication
   2. Detail 2: Pipe Hanger Support with attachment plate for 1/2-inch to 16-inch
      diameter pipe
      a. Grinnell Adjustable Clevis Hanger Figure 260 - hot-dip galvanized
      b. Grinnell Concrete Rod Attachment Plate - Figure 52260 - hot-dip galvanized
      c. Threaded rods and nuts - hot-dip galvanized
   3. Detail 3: Trapeze Pipe Hanger for pipes larger than 2-inch diameter
      a. Grinnell Universal Trapeze Assembly - Figure 46 - hot-dip galvanized
      b. Grinnell Concrete Rod Attachment Plates - Figure 52260 - hot-dip galvanized
c. Grinnell Strap - Figure 162 or U-bolt - hot-dip galvanized
d. Threaded rods and nuts - hot-dip galvanized

4. Detail 3: Trapeze Pipe Hanger for 2-inch diameter and smaller pipe
   a. Grinnell Concrete Rod Attachment Plates - Figure 52260 - hot-dip galvanized
   b. B-Line B22A Double U-channel - hot-dip galvanized
   c. B-Line B2400 Series pipe straps - hot-dip galvanized
d. Threaded rods and nuts - hot-dip galvanized

5. Detail 3: Single Pipe Wall Hanger
   a. Grinnell cast iron wall bracket, Figure 213, or fabricated steel equal - hot-dip galvanized
   b. Grinnell Adjustable Clevis Hanger Figure 260 - hot-dip galvanized
c. Threaded rods and nuts - hot-dip galvanized

6. Detail 4: Pipe Hanger - Wall Angle Bracket
   a. Welded steel wall bracket with double angle slot for suspending loads at fixed distances from walls or structures - hot-dip galvanized
   b. Grinnell Adjustable Clevis Hanger Figure 260 - hot-dip galvanized
c. Threaded rods and nuts - hot-dip galvanized

7. Detail 5: Single Pipe Support - Wall Angle Bracket
   a. Welded steel wall bracket with double angle slot for suspending loads at fixed distances from walls or structures - hot-dip galvanized
   b. Grinnell Strap - figure 162 or U-bolt - hot-dip galvanized

8. Detail 6: Multiple Pipe Support – Wall Angle Bracket
   a. Welded steel wall bracket with B-Line B22 U-channel welded to top angle - hot-dip galvanized
   b. B-Line B2400 Series pipe straps - hot-dip galvanized
c. Detail 224: Pipe strap detail for 2-inch and smaller diameter pipe
d. B-Line B2400 Series pipe straps - hot-dip galvanized
e. FRP or PVC spacer block

9. Detail 7: Stacked Ceiling or Wall System
   a. B-Line B22 U-channel - hot-dip galvanized - mounted to wall
   b. B-Line B2400 Series pipe straps or brackets as required- hot-dip galvanized

2.03 INSERTS

A. Inserts for concrete shall be hot-dipped galvanized steel with expander plug for threaded connection.
B. Size insert to suit threaded hanger rod.
C. Continuous inserts shall be Series P-3200 by Unistrut, PS-349 by Power Strut, or equal.
D. Split inserts shall be P-3295 by Unistrut, PS-2600 by Power Strut, or equal
2.04 DUCTWORK HANGERS
A. Sheet Metal Straps
   1. Galvanized straps shall conform to ASTM A 527 for lock-forming quality, and
      ASTM A 525 for coating designation G-90.
   2. Aluminum straps shall conform to ASTM B 209 for alloy MLA with H-14 temper.
   3. Stainless steel straps shall conform to ASTM A 167, Type 302, 304, or 316; and
      ASTM A 480, finish No. 1 or No. 4.
B. Ductwork hangers and supports shall be 1/8-inch thick by one inch wide bands or one
   inch by one inch channel or angle supports. Perforated bands shall not be acceptable.
C. Hangers and supports shall be trapeze type.
D. Fabricate ductwork hangers in accordance with SMACNA “HVAC Duct Construction
   Standards”.

2.05 UPPER ATTACHMENTS AND TRAPEZE CROSS-MEMBERS
A. Structural steel shapes and steel shapes shall conform to ASTM A36.

2.06 FASTENERS
A. Sheet metal screws shall be the same material as the duct.
B. Bolts and nuts shall be stainless steel unless otherwise noted.

2.07 ANCHOR BOLTS
A. Provide stainless steel anchor bolts, nuts and washers, Type 304, meeting requirements
   of Section 05500 and as indicated on the Drawings. Unless otherwise indicated, size
   anchor bolts to the largest diameter that will pass through the bolt holes of the equipment
   base. Length of the bolts shall be long enough to permit a minimum of one inch of grout
   beneath the base plate and a minimum of three inches anchorage into the structural
   concrete.
B. Provide anchor bolts, nuts and washers together with template or setting drawings
   sufficiently in advance to permit anchor bolts to be set either prior to or during structural
   concrete placement.

2.08 SUPPORTS AND BRACES
A. Provide supports and braces fabricated to meet requirements of Section 05500, other
   specification sections herein, and as indicated on the Drawings.

2.09 SHOP PAINTING
A. Clean and shop prime all non-galvanized, non-stainless steel metal in accordance with
   Standard Specifications Section 09900.

PART 3 EXECUTION
3.01 INSTALLATION
A. Pipe Hangers and Supports
   1. Horizontal metal pipe shall be supported in accordance with the following
      schedule:
         |
         Pipe Size          Maximum Hanger Spacing
         1/2 to 1-1/4 inch   6’ – 0”
         1-1/2 to 2 inch    10’ – 0”

Project No: W804000          15140-4          9/8/2010
Project Name: Broad Creek II Water Treatment Plant
2-1/2 to 3 inch 10’ – 0”
4 to 6 inch 15’ – 0”
Over 6 inch 17’ – 0”

2. Horizontal plastic pipe shall be supported in accordance with the following schedule:

<table>
<thead>
<tr>
<th>Pipe Size</th>
<th>Maximum Hanger Spacing</th>
</tr>
</thead>
<tbody>
<tr>
<td>1/2 to 1-1/4 inch</td>
<td>4’ – 0”</td>
</tr>
<tr>
<td>1-1/2 to 2 inch</td>
<td>5’ – 0”</td>
</tr>
<tr>
<td>2-1/2 to 3 inch</td>
<td>6’ – 0”</td>
</tr>
<tr>
<td>4 to 6 inch</td>
<td>6’ – 6”</td>
</tr>
</tbody>
</table>

3. Install hangers to provide minimum 1/2-inch space between finished covering and adjacent work.

4. Install a hanger within 12-inches of each horizontal elbow.

5. Use hangers with 1-1/2-inch minimum vertical adjustment.

6. Support horizontal cast iron pipe adjacent to each hub, with five feet maximum spacing between hangers.

7. Support vertical piping at wall.

8. Where several pipes can be installed in parallel and at same elevation, provide multiple or trapeze hangers.


10. Unless otherwise shown, specified or directed, no piping shall be from other piping, or from stairs, ladders or walkways.

B. Inserts

1. Concrete inserts shall have plastic coated filler to prevent concrete seepage.

2. Inserts shall be provided for suspending hanger rods and hangers from reinforced concrete slabs and sides of reinforced concrete beams.

3. Where concrete slabs form finished ceiling, inserts shall be provided flush with slab surface.

C. Ductwork Supports and Hangers

1. Unless otherwise specified, ductwork shall be supported a maximum of every ten feet on horizontal runs and a maximum of five feet on vertical runs.

2. A 1-inch wide metal shield shall be installed at each hanger or support between hanger and duct. A neoprene strip cushion, one inch wide, shall be installed between the shield and the duct.

3. Supports shall be located such that they coincide on joints, and shall be provided at each end of elbows and tee fittings.

4. Hangers and supports shall be installed such that they do not interfere with access doors or access to equipment.

5. For insulated pipe, provide insulation shields and high-density insulation inserts.

6. Support air terminal units independent of ductwork.

7. Support slot diffusers independent of suspended ceiling grid.

D. Upper Hanger Attachments

1. Upper hanger attachments shall be made of structural steel wherever possible.
2. Power driven pins shall not be used.
3. Expansion nails shall not be used.
4. Powder driven fasteners shall not be used in precast concrete.
5. Loads in excess of 250 pounds shall not be supported from a single welded or powder-driven stud.

E. Steel Frame Construction
1. Provide intermediate structural steel members where required by ductwork support spacing.
2. Secure upper hanger attachments to steel bar joists at panel points.
3. Holes shall not be drilled in structural steel members.
4. Friction clamps shall not be used.

3.02 FIELD PAINTING
A. Field prepare and paint required surfaces as specified in Section 09900.

END OF SECTION
SECTION 15550
FUEL TANK

PART 1 GENERAL

1.01 DESCRIPTION
A. This Section shall include a complete above ground fuel storage system for the emergency generator including fuel piping and accessories, vent piping, connections and level monitoring required for a complete installation.

1.02 QUALITY ASSURANCE
A. All equipment furnished under this Section shall be furnished by manufacturers who meet the quality, workmanship, and experience requirements as specified in the General Provisions section of this Contract.

1.03 RELATED WORK SPECIFIED ELSEWHERE
A. Power Generation: 16200.

1.04 SUBMITTALS
A. Submittals and samples shall be submitted in accordance with the provisions set forth in the General Provisions.
B. Submit shop drawings in accordance with Section SP-09.
C. Prior to obtaining any material in connection with this Section, detailed shop drawings on all material shall be submitted.
D. Submittals shall contain a material list with manufacturer data describing the material and showing its compliance with specifications, associated standards and test requirements.
E. Submittals shall include mounting details, field specific piping diagrams indicating connections to the tank and emergency generator. Submittals shall include catalog cuts and installation diagrams for the tank and level gauge.
F. Submit a copy of manufacturer’s warranty for the fuel storage tank.
G. Submit a copy of manufacturer’s certificates in accordance with Section SP-08.
H. Submit a copy of the factory and field pressure tests.
I. Submit Operations and Maintenance Manual in accordance with Section SP-10.

PART 2 - PRODUCTS

2.01 MATERIALS
A. General
1. The Contractor shall furnish and install an above ground fuel storage tank as specified herein. The Contractor shall verify pipe fittings, connections and accessories required to connect the fuel storage tank to the emergency generator.
2.02 FUEL STORAGE TANK

A. An above grade fuel storage tank with secondary containment shall be provided for diesel fuel storage. The fuel storage tank shall carry a minimum of a 20-year written warranty and shall include the following:

1. Tank shall be UL Listed and shall comply with the requirements set forth in UL 142, "Steel Above Ground Tanks for Flammable and Combustible Liquids".

2. The tank shall be constructed of a minimum of 10 gauge (3/16") steel of all welded construction with rust preventative.

3. Secondary containment shall be a six-inch thick, reinforced concrete vault providing 360-degree protection of the interior tank. Concrete shall have a minimum compressive strength of 4000 psi at 28 days. Secondary containment shall provide a minimum capacity of 110% of the interior storage tank and shall be factory constructed as an integral part of the fuel storage tank.

4. The tank construction shall include thermal insulation equivalent to .25 inches of polystyrene to protect against temperature extremes, and to protect against corrosion by isolating the steel tank from the concrete or other corrosive material. All steel exterior to the concrete encasement shall be anti-oxidant powder coated to inhibit corrosion and meet A.S.T.M. B117.

5. The tank system shall include an impervious barrier of 30 mil high-density polyethylene to contain leaks from the primary tank. A monitoring tube shall be located between the inner tank and the secondary barrier.

6. Overfill protection shall be provided by the following methods:
   a. Valve rated for pressurized delivery located within fill pipe to close automatically at 95% full level
   b. High level alarm

7. Tank system shall include a 2" atmospheric vent and emergency venting in accordance with N.F.P.A. 30.

8. The tank system including accessories shall be installed in strict accordance with the manufacturer’s recommendations and applicable fire and environmental codes. All state and local permits shall be obtained by contractor prior to installation.

9. Tank shall include readily accessible grounding lugs located on the tank saddle. Ground lugs shall be factory connected to the tank with a 4/0 copper grounding conductor.

10. Fuel storage tank shall be suitable for storage of No. 2 diesel fuel oil.

11. Threaded pipe connections, bushings, end caps, and couplings for tank fill, generator pump suction, fuel return, overflow, vent and drain shall be provided as required to perform connections as indicated herein and on the Contract Drawings. Tank fill pipe shall be capped, and shall be readily accessible for filling the tank. Tank fill cap shall include provisions for locking the cap in the closed position.

12. Atmospheric galvanized steel vent pipe shall be provided for venting the tank. The vent pipe shall extend a minimum of 12 feet above grade. Stainless steel anchors and supports shall be provided to support the vent pipe. Provisions shall be provided to ground the vent pipe to the underground grounding grid.
13. An emergency vent shall be provided in accordance with the requirements of applicable local codes.

14. Level gauge shall be a mechanical float type device suitable for outdoor installations. Level gauge shall be provided with required couplings and connections. In addition to the level gauge, a dipstick shall be provided for manual level inspection of the tank. The level gauge and dipstick shall be clearly marked and shall be coordinated with the tank size to monitor the entire capacity of the tank. Furnish and install a 4" or 6" clock style tank level gauge. Level gauge shall be the self-acting, continuous direct reading type. Readout format shall be on a standard 12 hour clock face. Small hand representing the feet and large hand inches. Fuel level gauge shall be mounted at location where it is accessible and readable. Gauge shall be readable up to 20-30 ft away, and shall be model 918 as manufactured by Morrison Bros. Co., or equal.

2.03 FUEL OIL PIPING

A. Piping between the fuel tank and the generator shall be a minimum of 3/4-inch in diameter and of sufficient size as required by the generator manufacturer for this application. Piping material shall be compatible with the tank to prevent galvanic corrosive action. Pipe shall be provided with couplings and fittings as required to connect the fuel tank to the generator engine. Pipe shall be provided with necessary hangers and supports between the fuel tank and the generator to support the piping.

B. Flexible connections shall be provided for the supply and return line connections to the generator engine. Valves that are required to be installed by applicable NFPA or local codes and shown on the drawings shall be provided.

2.04 BALL VALVE

A. Ball valve shall be a 2-piece full port design constructed of a forged brass body and end adapter. Seats and stem packing shall be virgin PTFE. Stem shall be bottom loaded, blowout proof design with fluorocarbon elastomer O-ring to prevent stem leaks. Valve shall have chrome plated brass ball and adjustable packing gland. Threaded valves shall be CSA approved and 125 psig UL/FM approved and certified to NSF/ANSI standard 61/8. Valve shall be rated 600 psi WOG non-shock and 150 psi WSP. Ball valve shall be suitable for use on diesel.

2.05 SIGNS AND LABELS

A. Warning signs and labels shall be provided on the exterior of the fuel storage tank to indicate fuel content, tank filling procedures and any applicable information as required to meet applicable code requirements. Signs and labels shall be suitable for installation in outdoor locations.

B. Fuel piping shall be appropriately labeled as follows:
   1. Fuel Supply Line.
   2. Fuel Return Line.

PART 3 EXECUTION

3.01 INSTALLATION

A. The fuel storage tank and accessories shall be installed in the location indicated on the Contract Drawings. The fuel storage tank shall be installed according to applicable codes and the manufacturer’s instructions. Provide a concrete pad for mounting the fuel tank.

B. Piping shall be installed above grade as shown on the Contract Drawings. Piping shall be
supported as required to make connections between the fuel storage tank and the emergency generator.

C. Tank shall be grounded to the facility ground loop.

D. Warning signs and labels shall be installed in such a manner to as to meet local code requirements. Warning signs and labels for fuel piping shall be installed after heat tracing, insulation and metal jacket have been installed and tested for operation.

E. Contractor shall provide all fuel to run the generator for startup and testing procedures of the emergency generator system. Upon completion of all testing the Contractor shall fill the tank to maximum capacity with winter mix No. 2 diesel fuel oil.

F. Tank shall be pressure tested at the factory and in the field at 5 psig for a minimum of one hour. Test reports shall be submitted with the Operations and Maintenance Manuals.

G. The tank construction shall include thermal insulation equivalent to .25 inches of polystyrene to protect against temperature extremes, and to protect against corrosion by isolating the steel tank from the concrete or other corrosive material. All steel exterior to the concrete encasement shall be anti-oxidant powder coated to inhibit corrosion and meet A.S.T.M. B117.

H. Overfill protection shall be provided by the following methods:
   1. Valve rated for pressurized delivery located within fill pipe to close automatically at 95% full level.
   2. High level alarm.

I. Provide aluminum walk-way kit to allow access serviceable parts of the external fuel storage tank

END OF SECTION
SECTION 15835
HEAT TRANSFER UNITS

PART 1 GENERAL

1.01 DESCRIPTION
A. This Section includes requirements for electric unit heaters as indicated in accordance with the Contract Documents.

1.02 QUALITY ASSURANCE
A. All equipment furnished under this Section shall be furnished by manufacturer's who meet the quality, workmanship, and experience requirements as required by the General Provisions.

1.03 SUBMITTALS
A. Submit shop drawings in accordance with Section SP-09
B. Submittal shall include, but not be limited to, the following:
   1. Catalog data for electric unit heaters.
   2. Mounting details, electrical service connections, schedules of equipment, cross sections of cabinets, grilles and bracing, and wiring diagrams.
   3. Manufacturer's installation instructions for electric unit heaters.
C. Submit Operations and maintenance manual in accordance with Section SP-10.

PART 2 MATERIALS

2.01 CORROSION RESISTANCE ELECTRIC UNIT HEATERS
A. Electric Unit Heaters shall consist of the following components:
   1. Heater cabinet
   2. Heater coils
   3. Heater fan
   4. Louvers
   5. Wall mounting bracket
   6. Magnetic contactors
   7. Control power transformer
B. Heaters shall be capable of operation on voltages indicated on the Drawings, with capacities as scheduled on the Drawings.
C. Unit shall be provided with rust resistant fin tube elements attached to junction box with leak-proof threaded fittings for maximum corrosion resistance.
D. Unit heaters shall be provided with a NEMA 4X molded fiberglass junction box. Junction box shall house built-in controls which shall include two power contactors (primary and backup), motor contactor and fused transformer for 120V control circuit.
E. Unit shall be provided with a stainless steel swivel mounting bracket.
F. Unit shall be provided with a built-in overload protection provided by an epoxy sealed automatic and manual (back up) reset thermal cutout.
G. Unit shall be provided with an epoxy sealed thermal fan delay allowing the fan motor to continue to operate after heating thermostat has been satisfied to maximize transfer of generated heat to space being heated and extend operating life of heating element.

H. Unit shall be provided with a totally enclosed fan motor with permanently lubricated ball bearings for long life. Motor shall be resistant to moisture and corrosion, and shall be provided with integral overloads.

I. All hardware shall be stainless steel.

J. Unit shall be provided with adjustable louvered outlet grille to direct air flow up or down. Grille shall be painted with one coat of zinc chromate primer and two coats of corrosion resistant paint.

K. Unit shall be provided with heavy-gage rear wire grille to protect against accidental contact with the fan. Finish shall be the same as the grille.

L. Unit shall be provided with a pilot light to indicate power on.

M. Unit shall be suitable for water contact associated with periodic water wash downs.

N. Heater shall be controlled with integral thermostat.

O. Heater shall be provided with integral disconnect switch.

P. Electric Unit Heaters shall be as manufactured by:

1. CHROMALOX Model HD3D or equal

2.02 DRY LOCATION ELECTRIC UNIT HEATERS

A. Electric Unit Heaters shall consist of the following components:

1. Heater cabinet
2. Heater coils
3. Heater fan
4. Louvers
5. Wall mounting bracket
6. Magnetic contactors
7. Control power transformer

B. Heaters shall be capable of operation on voltages indicated on the Drawings, with capacities as scheduled on the Drawings.

C. Heater casing shall be constructed of Die-formed heavy gauge steel finished.

D. Individual adjustable louvers shall be furnished to provide desired control of discharge air.

E. All metal surfaces of the casing shall be phosphate coated to resist corrosion, and finished in gray powder coated paint.

F. Automatic reset thermal overheat protection shall be wired for instantaneous de-energizing of the heating element in case of thermal overload.

G. Complete enclosure fan motor.

H. Fan shall be aluminum, directly connected to fan motor, dynamically balanced and design for unit heater applications.

I. Provide motor contactor and fused transformer for 120V control circuit.
J. Unit shall be provided with an epoxy sealed thermal fan delay allowing the fan motor to continue to operate after heating thermostat has been satisfied to maximize transfer of generated heat to space being heated and extend operating life of heating element.

K. Fan motor shall be furnished with integral overload.

L. Aluminum-finned, cooper clad steel sheath heating element.

M. Unit shall be provided with a pilot light to indicate power on.

N. Heater shall be controlled with integral thermostat.

O. Provide internal fan switch.

P. Heater shall be provided with integral disconnect switch.

Q. Provide mounting brackets for either ceiling or wall swivel mounting as shown on drawings.

R. Electric Unit Heaters shall be as manufactured by:
   1. CHROMALOX Model LUH or equal

PART 3 EXECUTION

3.01 INSTALLATION

3.02 Install all equipment in accordance with the manufacturer's recommendations. Make all necessary adjustments to equipment to provide complete and satisfactory operation upon completion of the installation.

3.03 PAINTING

3.04 Structural steel for supporting units shall be painted in accordance with the requirements of Section 09900. Fasteners and hardware shall be cadmium plated or stainless steel.

3.05 TESTING

A. The electric unit heaters shall be tested as follows:
   1. Demonstrate automatic and manual operation.
   2. Verify that heater discharge louvers provide air discharge pattern to get heat to the floor.

END OF SECTION
PART 1 GENERAL

1.01 DESCRIPTION
A. This Section includes requirements for the centrifugal fans and their accessories as indicated in accordance with the Contract Documents. Fans and dehumidifiers for the facility shall be provided for the specified air changes per hour of continuous operation.

1.02 QUALITY ASSURANCE
A. All equipment and materials furnished under this section shall be furnished by manufacturers who meet the quality, workmanship, and experience requirements as specified and in accordance with the following references:
   1. Air Moving and Control Association (AMCA).

1.03 SUBMITTALS
A. Submit Contractor’s drawings in accordance with Section SP-09
B. Submittal shall include, but not be limited to, the following:
   1. Shop drawings for fans including: construction details, arrangement, materials, unit dimensions, accessories, weight loading, required clearances, sound power levels for fan inlet and outlet and casing radiation at rated capacity, and performance curve for each fan at the design speed. The fan curves shall show brake horsepower, static pressure, static efficiency plotted against air volume for the duty scheduled and electrical connections.
   C. Submit Manufacturer’s Certification and Certificate for all fans and dehumidifiers in accordance with Sections SP-07 and SP-08. Submit copies of test reports with certificates.
   D. Submit operation and maintenance manual in accordance with Section SP-10.

PART 2 MATERIALS

2.01 GENERAL
A. Fans shall be capable of accommodating static pressure variations of plus or minus ten percent.
B. Fans shall be statically and dynamically balanced to eliminate vibration or noise transmission to process or occupied areas.
C. Refer to schedule on drawings for fan ratings.

2.02 EXHAUST FAN
A. Fan shall be a spun aluminum, wall-mounted, direct-driven, horizontal centrifugal exhaust ventilator.
B. Fan shall be listed by Underwriters Laboratories (UL705) and shall bear the AMCA certified rating seal for sound and air performance.
C. Fan shall be bolted and welded construction utilizing corrosion resistant fasteners. The spun aluminum structural components shall be constructed of minimum 16 gauge marine alloy aluminum, bolted to a rigid aluminum support structure. The wind band shall have a rolled bead or similar construction for added strength. Stainless steel quick release latches shall be provided for access into the motor compartment. All integral conduits shall be provided into the motor compartment to facilitate wiring connections. The motor, bearings, and drive shall be mounted on a minimum 14 gauge steel assembly, isolated from the unit structure with rubber vibration isolators. These components shall be enclosed in a weather-tight compartment, separated from the exhaust airstream.

D. Wheel shall be centrifugal backward inclined, constructed of 100% aluminum. Wheel shall be balanced in accordance with AMCA standards.

E. Motor shall be heavy duty type with permanently lubricated sealed bearings and furnished at the specified voltage, phase and enclosure.

F. Fan shall be Loren Cook Model ACW-D, or Greenheck or equal.

2.03 FAN CONTROLS
A. The fans will operate via a line rated thermostat.
B. Thermostat and freeze stat shall be line rated type with double pole double throw dry contacts for operation of exhaust fan. Thermostat shall be rated for installation in wet locations with NEMA 4X cover.
C. Provide Fan Speed Control (FSC) as shown on Drawings.

2.04 DEHUMIDIFIER
A. The Contractor shall provide and install an industrial rated high efficient dehumidifier in location shown on the Contract Drawings. Dehumidifier unit shall be mounted and supported on a painted steel wall shelf as shown on drawings. Shelf shall be reinforced to support weight of the dehumidifier unit.
B. The dehumidifier unit shall have a rated dehumidification capacity of a minimum of 192 pints per day at 80 °F, 60% RH, 540 CFM. Unit shall have a minimum operating temperature range of 40 °F with automatic coil ice detection and thawing function. The unit shall be controlled by an integrated adjustable humidistat to automatically start and stop operation at the desired set point. Unit shall be provided with required drain tube attachment and condensate pump.
C. The unit shall be provided with 16 gauge steel galvanized or painted cabinet and a removable and cleanable foam air filter. Contractor shall provide one spare air filter.
D. The industrial dehumidifier unit shall be rated for continuous operation on 120 Volt, 60 Hertz AC power. Unit shall be powered with plug and cord to a dedicated wall receptacle or hardwired to circuit as indicated on the drawings.
E. The Contractor shall provide and install a PVC drain tube from the dehumidifier unit to the floor drain. Contractor shall coordinate the PVC pipe size with the dehumidifier unit. Coordinate the actual routing of the drain line and floor drain with the Engineer during installation.
F. Dehumidifier unit shall be as manufactured by Oasis, Woods, or equal.

PART 3 EXECUTION
3.01 EXAMINATION
A. Examine units at time of delivery for damaged or missing components. Do not proceed with installation of units until all items found defective upon examination have been corrected.
B. Verify that opening dimensions are as indicated on shop drawings as required by the manufacturer.

C. Verify that proper power source is available.

3.02 INSTALLATION

A. Install fans of type, capacity and in locations noted on the drawings.

B. Install the Work of this section in strict accordance with the manufacturer’s printed instructions and the requirements of the Contract Documents.

C. Coat all aluminum surfaces in contact with concrete or masonry.

D. Provide safety screens where inlet or outlet is exposed.

E. Openings in wall for mounted fans shall be sealed watertight around fan frame with heavy-duty water-resistant caulking.

3.03 TESTING

A. Demonstrate fans and dehumidifier operation

B. Contractor shall perform testing of the rated velocity of each fan, at the fan to demonstrate the specified operation. Submit results to the engineer.

END OF SECTION
SECTION 15990
HVAC SYSTEM ADJUSTING AND BALANCING

PART 1 GENERAL

1.01 DESCRIPTION
A. This Section includes requirements for adjusting and balancing of ventilation systems.

1.02 QUALITY ASSURANCE
A. Manufacturers who meet the quality, workmanship, and experience requirements as specified in the General Provisions Section of this Contract shall furnish equipment furnished under this Section.

B. Adjusting and Balancing Agency's Qualifications: Firm certified by National Environmental Balancing Bureau (NEBB) in those disciplines similar to those required for this project. Firm shall not be the installer of the system being adjusted and balanced and shall otherwise be independent of the project. Firm shall be a member in good standing with NEBB for a minimum of five (5) years.

C. Comply with recommended procedures for examination, preparation, and performance of adjusting and balancing, as outlined in the referenced NEBB standard, for mechanical air and liquid distribution systems and their associated equipment.

D. Comply with ASHRAE recommendations pertaining to measurements, instruments, and adjusting and balancing; except as otherwise indicated.

1.03 SUBMITTALS
A. Submittals shall be developed and submitted in accordance with the requirements of Section SP-09 and shall include, but not be limited to, the following:

1. Submit name of the adjusting and balancing (AB) agency for approval within 30 days after award of Contract. Submittal shall also include certification by the adjusting and balancing agency affirming membership in good standing with NEBB or AABC for the time frame specified herein.

2. Adjusting and Balancing Reports
   a. Submit report(s) on NEBB or AABC forms. Submit draft copies of report for review prior to performance of adjusting and balancing Work. Include adjusting and balancing instrument calibration history with draft report.

   b. Submit certified adjusting and balancing reports bearing the seal and signature of the Adjusting and Balancing Engineer. The reports shall be certified proof that the systems have been adjusted and balanced in accordance with the referenced standards; are an accurate representation of how the systems have been installed; are a true representation of how the systems are operating at the completion of the adjusting and balancing procedures; and are an accurate record of final quantities measured to establish the normal operating values of the system.

   c. Provide reports in soft cover, letter size, 3-ring binder, complete with index page and indexing tabs, with cover identification on front and spine. Include system schematic drawings and/or reduced drawings with air outlets and inlets, balancing dampers and fittings, and equipment identified to correspond with report forms. Include calibration histories of test instruments used.
d. Report shall be divided by system type and subdivided within each type by individual systems (e.g., Exhaust Air System, Air Handling Unit Distribution System, etc.).

e. Submit detailed procedures, agenda, sample report forms indicating all adjusting, balancing and equipment data required, system schematics, and samples of patching plugs, stamped brass tags, and caulking sealant for approval prior to commencing system(s) balance.

f. Submit detailed drawings for non-ducted equipment balancing, including temporary ductwork size and details of temporary ductwork support, connection to equipment, as well as repair to equipment at the point of connection.

1.04 SEQUENCING AND SCHEDULING

A. Sequence Work to commence after completion of system installation and before conditional acceptance of project.

B. Provide written notification to the Engineer a minimum of five (5) working days prior to the performance of adjusting and balancing Work. Perform adjusting and balancing work in the presence of the Owner’s designated Representative.

1.05 WARRANTY

A. Adjusting and balancing results shall be warranted to maintain setting and adjustment and to perform as stated in the test report for 90 days from the date of final adjustments.

B. Balancing Contractor shall be subject to recall to the site to verify results before approval of balancing test report.

PART 2 MATERIALS

2.01 QUALIFICATIONS

A. Adjusting and balancing shall be performed by a company specializing in the adjusting and balancing of heating, ventilating and air conditioning systems specified in this Section having a minimum of five years experience and shall be certified by AABC or NEBB. The adjusting and balancing contractor shall not be the installer of the system and shall otherwise be independent of the project. Individuals qualified for that work by the AABC or the NEBB shall perform system balancing. Proof of such qualifications, outlines of proposed balancing procedures, and data sheets for the specific instrument to be used, listing their most recent calibration dates shall be submitted for approval. The balancing procedures used shall meet the recommendations of the ASHRAE as published in the 1991 ASHRAE Systems and Applications Handbook under the chapter headed Testing, Adjusting and Balancing, and shall be witnessed by the Engineer.

2.02 DETAILED MATERIAL REQUIREMENTS

A. Adjusting and balancing instruments and equipment.

1. Adjusting and balancing instruments and equipment used shall be selected to provide the precision stated in this specification and capacity requirement as indicated on the Contract Drawings for the system(s) being tested. Selection shall follow the guidelines on NEBB; preference shall be given to instruments, which are required for NEBB certification.

2. Adjusting and balancing instruments and equipment used shall be company owned and remain the property of the company. Use adjusting and balancing instruments that are in first class operating condition with individual calibration histories to guarantee accuracy. Include instrument calibration histories in the test report.
B. Patching Materials.
   1. Circular Plastic Plug: with retainer, size to fit tightly into drilled hole.
   2. Sheet Metal: Material and gage shall match ductwork or housing, cut to allow minimum of one inch lap all around.
   3. Caulking Sealant: silicone rubber; Dow Corning "732" or equal.

PART 3 EXECUTION

3.01 GENERAL

A. Adjusting and balancing Work shall follow recommended procedures for examination, preparation, and performance of adjusting and balancing, as outlined in the referenced NEBB standard.

B. Prior to commencing any final adjusting or balancing Work, the Contractor shall verify that duct-work and accessories for each system has been completely installed and is ready for operation. Contractor shall verify the following:
   1. Electrical service has been installed to motors and controls.
   2. Motor overloads have been installed.
   3. Fans have been inspected for correct rotation.
   4. Duct systems are clean of debris.
   5. Access doors, test holes and duct drains have been closed and plugged.
   6. Mating flanges shall be within 1/16” tolerance unbolted.
   7. Flange face separation shall be no greater than 1/16” beyond normal gasket thickness.

C. The Contractor shall notify the Engineer five full working days prior to beginning adjusting and balancing.

D. After adjusting and balancing is complete the Contractor shall leave systems in proper working order, replacing belt guards, closing access doors, closing doors to electrical boxes and panels, and restoring thermostats to specified settings.

E. Where HVAC equipment is non-ducted, the Contractor shall provide temporary ductwork as required in order to measure air flow and static pressure. Temporary ductwork shall be removed after airflow measurement and balancing is complete.

3.02 EXAMINATION

A. Examine installed Work and conditions under which adjusting and balancing is to be done to ensure that work has been completed, cleaned, and is operable.

B. Report any defects or deficiencies noted during examination to Engineer. Promptly report abnormal conditions in mechanical systems or conditions, which prevent system balance.

3.03 PREPARATION

A. Prepare schematic system drawings indicating proposed measurement points. Fill in known equipment data on report forms for components and equipment to be tested or balanced.

B. Submit schematics and partially completed test forms for approval prior to commencement of Work.

C. Incorporate any comments on the sample schematics and/or forms into balancing procedure.
3.04 INSTALLATION TOLERANCES
A. Adjust air handling systems to plus or minus 5 percent for supply systems and plus or minus 10 percent for return and exhaust systems from scheduled values.

3.05 AIR SYSTEM PROCEDURES
A. Adjust air handling and distribution system to provide required or design supply, return, and exhaust air quantities as identified herein.
B. Use volume control devices to regulate air quantities only to the extent those adjustments do not create objectionable air motion or sound levels. Effect volume control by duct internal devices such as dampers and splitters.
C. Provide system schematics with required and actual air quantities recorded at each outlet and inlet.
D. Sound pressure level measurements shall be taken at each fan location. Measurements shall be taken at distances of five feet, ten feet, and twenty feet from the fan with the fan operating, and with the fan not operating. Measurements shall be taken at four separate points at each distance. Measurements shall be taken on each side of the wall of a wall-mounted fan, and on the interior and exterior of the roof for the upblast fan. Measurements shall be taken in the presence of the Engineer.

3.06 REPORT PREPARATION
A. Prepare report of test results, including instrumentation calibration histories, in format recommended by referenced NEBB standard.
B. Submit draft of report for approval.

3.07 FINAL COMPLIANCE PROCEDURE
A. The following items of the Work are to be carried out only after acceptance of the adjusting and balancing report.
   1. Final Inspection.
      a. Recheck random selections of data recorded in report. Take measurements to verify balance has not been disrupted or that such disruption has been rectified.
      b. Verify that systems are in proper working order, belt guards have been replaced, access doors have been closed, doors to electrical boxes and panels have been closed, and thermostats have been restored to specified settings.
   2. Marking of System Settings
      a. Mark equipment and control device settings to show final settings at completion of adjusting and balancing Work.
      b. After final check of the systems has been performed, the Contractor shall provide stamped brass tags at each volume control damper and fan indicating the following information:
         (1) Flow (CFM)
         (2) Velocity (FPM)
         (3) Damper position
         (4) Date readings were taken
   3. Lock memory stops.
4. Patching

a. Patch holes drilled in ductwork and equipment housings for adjusting and balancing purposes using plastic plugs with retainers.

b. Patch non-circular and larger holes using sheet metal of like material and gage. Secure patch to duct or housing using aluminum or stainless steel pop rivets. Seal patch using silicone rubber caulking. Degrease, prepare, and prime paint patch.

END OF SECTION
PART 1 GENERAL

1.01 DESCRIPTION
A. This section includes materials, installation, and testing of the electrical system.

1.02 REGULATORY AGENCIES AND STANDARDS
A. Regulatory Agencies: Installations, materials, equipment, and workmanship shall conform to the provisions of the following agencies:
   2. Occupational Safety and Health Act (OSHA).
   3. Local authorities having lawful jurisdiction pertaining to the work required.
B. Underwriter’s Laboratories, Inc. (UL): Materials, appliances, equipment, and devices shall conform to the applicable UL standards. The label of, or listing by, UL is required wherever applicable.
C. Standards: Where referenced in these specifications or on the drawings, the publications and standards of the following organizations apply:
   5. Institute of Electrical and Electronics Engineers (IEEE).
   6. Insulated Cable Engineers Association (ICEA).

1.03 UTILITY COMPANY REQUIREMENTS AND FEES
A. The County will apply for electric and telephone service. The County will pay utility company fees, cable charges, and added facilities charges.
B. The Contractor shall provide all coordination for service with the utility company.
C. Provide and install electric service entrance equipment, conduit, wire, and devices in accordance with the serving utility’s requirements. Coordinate with the serving utility to ensure timely connection by the utility. Obtain utility company approval of service entrance and metering equipment shop drawings prior to starting fabrication.

1.04 SUBMITTALS
A. Submit shop drawings in accordance with SP-09.
B. Operations and Maintenance Manuals:
   1. Operations and maintenance manuals are prepared and submitted in accordance with Section SP-10.
   2. Submit O&M Manual for the following equipment:
      a. Protective Device Coordination Study – Section 16011
      b. Miscellaneous Electrical Devices – Section 16051
      c. Fiber Optic cable and accessories – Section 16125
d. Low voltage Motor Control – Section 16155

e. Variable Frequency Drives – Section 16157

f. Panel boards – Section 16160

g. Lighting – Section 16500

h. Surge Suppression – Section 16670

i. Heat tracing of process piping – Section 16855

C. Submit manufacturer’s certificates in accordance with Section SP-08.

1.05 ELECTRICAL SERVICE CHANGES

A. These specifications and drawings delineate the remodeling of an existing structure, and/or the addition to an existing structure. While the existing structure is occupied, keep the present services intact until the new construction, facilities, or equipment is installed.

1.06 MANUFACTURER’S SERVICES

A. The Contractor shall refer to the special provisions for the requirements of the manufacturer services for all equipment provided in Division 16 of the Contract Documents. The services indicated in the special provisions shall be in addition to those indicated in the specification sections.

PART 2 MATERIALS

2.01 Similar materials and equipment shall be the product of a single manufacturer. The disconnect switches, motor control center, combination starters, panel boards, and manual motor starters shall be products of one manufacturer.

2.02 Provide only the products which are new, undamaged, and in the original cartons or containers.

2.03 Materials and equipment shall be the standard products of manufacturers regularly engaged in the production of such material and shall be the manufacturer’s current design.

2.04 Materials and equipment shall be suitable for storage, installation, and operation in an ambient of 0°C to 40°C except where more stringent conditions are stated in individual equipment specifications.

2.05 Electrical equipment and panels shall be factory finished with manufacturer’s standard primer and enamel topcoats, unless stated otherwise in the individual equipment specifications. Provide 1 pint of the equipment manufacturer’s touchup paint per 500 square feet of painted surface for repair of damaged enamel topcoats.

2.06 HAZARDOUS LOCATIONS

A. Conform with NEC Articles 501 and 502 for areas identified as “Hazardous Areas.”

B. Hazardous Class 1, Division 1, areas are identified in Paragraph 2.7, D.

C. Hazardous Class 1, Division 2, areas are identified in Paragraph 2.7, D.

D. Provide equipment with ratings suitable for installation in the hazardous location identified.

2.07 CLASSIFICATIONS OF EQUIPMENT

A. NEMA type Enclosure Classifications

1. NEMA 1 – Dry locations, use only for VFD enclosures and panelboards.

2. NEMA 12 – Dry locations, all other equipment not in Item 1 above.

3. NEMA 4X (Stainless Steel) – Wet locations (exterior), and corrosive locations.
4. NEMA 7/9 – Hazardous locations, not corrosive locations.

5. NEMA 7/9 (Corrosive) – Hazardous locations, corrosive locations.

B. NEMA Type Panel Device and Component Classifications

C. All panel devices, instrumentation, and electrical components installed shall satisfy the NEMA type classification of the associated panel:

1. Dry Locations – NEMA 12
2. Wet Locations – NEMA 4X
3. Corrosive Locations – NEMA 4X

D. Area Classification Schedule

<table>
<thead>
<tr>
<th>Area Description</th>
<th>Hazardous Location</th>
<th>Dry Location</th>
<th>Wet Location</th>
<th>Corrosive Location</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electrical Room</td>
<td></td>
<td>X</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Aerator Area</td>
<td></td>
<td>X</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Blowdown Room</td>
<td></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Control Panel Room</td>
<td></td>
<td>X</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Filter Room</td>
<td></td>
<td></td>
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<td>X</td>
<td>1</td>
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<tr>
<td>Clearwell Room</td>
<td></td>
<td>X</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Effluent Vault</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Out-site Location</td>
<td></td>
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<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lime Room</td>
<td></td>
<td>X</td>
<td>X</td>
<td></td>
<td>1</td>
</tr>
</tbody>
</table>

Notes:
1. “Corrosive” is not an NEC classification, it refers to rooms with chemicals stored in them.

E. MOUNTING HARDWARE

Provide type 306 stainless steel mounting channel, minimum 1-5/8”, stainless steel anchor bolts, and stainless hardware for mounting all equipment, unless otherwise noted. Refer to Section 05100.

PART 3 EXECUTION

3.01 INSTALLATION

A. The drawings indicate connections for typical equipment only. If the equipment furnished is different from what is shown, provide the modifications necessary for a safe and properly operating installation in accordance with the equipment manufacturer’s recommendations.

B. The drawings diagrammatically indicate the desired location and arrangement of outlets, conduit runs, equipment, and other items. Field determine exact locations based on physical size and arrangement of equipment, finished elevations, and obstructions.
C. Work or equipment not indicated or specified which is necessary for the complete and proper operation of the Electrical systems shall be accomplished without additional cost to the Owner.

D. Review demolition methods with Owner’s Representative prior to cutting or removing existing architectural and/or structural items or equipment. Repair damage to match existing, and maintain the fire rating of the existing items affected by work.

3.02 REMOVAL OR RELOCATION OF MATERIALS AND EQUIPMENT

A. Refer to Section 02050.

B. Unless otherwise noted, remove existing electrical materials and equipment from areas indicated for demolition or where equipment is relocated. Remove materials no longer used, such as studs, straps, and conduits. Remove or cut off concealed or embedded conduit, boxes, or other materials and equipment to a point at least ¾ inch below the final finished surface. Remove existing unused wires.

C. Repair affected surfaces to conform to the type, quality, and finish of the surrounding surface.

3.03 IDENTIFICATIONS AND SIGNS

A. Mark each individual panelboard, motor controller, disconnect switch, timer, relay, and contactor to identify each item with its respective service or function. Provide nameplates with engraved lettering not less than ¼ inch high. Use black-on-white laminated plastic, attached with rivets or stainless steel sheet metal screws. Do not use embossed plastic adhesive tape.

3.04 INFRARED SURVEY/TESTING

A. General

Conduct an infrared survey of major electrical and rotating equipment in readings taken should be done with the equipment operating under loaded conditions. Motor starters shall be loaded at the full load ampere rating of the motor. All other equipment, unless indicated otherwise, shall be loaded at 80% of the overcurrent protective device rating ahead of the equipment. All equipment shall be loaded for a minimum of 30 minutes before scanning. A Load Bank, provided by the Contractor, shall be used when the connected equipment cannot provide the required load.

B. Equipment to be Tested

1. Switchgear
2. Motor Control Center and Variable Frequency Drives.
3. Bus Bars, Bus Splices, Bus Connectors.
4. Main Breakers.
5. Motor Connections at Motor.
6. Lighting Panels, Transformers and other ancillary equipment (under normal station load).
7. Connections to Load Bank Connection Box and Manual Transfer.

C. Infrared Scanning of Electrical Equipment

1. Visual Inspection
   a. Inspect for physical, electrical, and mechanical condition and bus alignment.
2. Infrared Inspection  
a. Perform a qualitative (Level I) infrared inspection on the equipment listed in Section 3.04.B above. The infrared-scanning device used shall meet the requirements contained in Part 4 below.

3. Provide a report indicating the following.  
a. Location, equipment, date.  
b. Problem area (location of “hot spot”).  
c. Indicate temperature of “hot spot” and ambient temperature.  
d. Indicate cause of heat rise, if known.  
e. Indicate phase unbalance, if present.  
f. List of areas scanned.

4. Test parameters  
a. Infrared scanning equipment shall detect 1 degree C rise between subject area and reference at 30 degrees C.  
b. Equipment shall detect emitted radiation and convert detected radiation to visual signal.  
c. Both identifying photographs and thermographic photos shall be provided of the deficient areas. The thermographic photos shall be as seen on the imaging system. The thermographs and identifying photos shall be contained in the report to provide a baseline inventory of the electrical system immediately preceding conditional acceptance.

5. Test Results/Tolerances  
a. Per InterNational Electrical testing Association (NETA), operating temperature shall not exceed the manufacturers or listing agency’s rating for the equipment or attached conductors. The following temperature tolerances are for equipment temperature ratings of 75 degrees C or above.

(1) The following tolerances are applied to temperature gradients/differences based on comparison between phases on balanced three phase loads:

(A) Temperature of 15 degrees C or more: Contractor to correct problem immediately and re-test.

(B) Temperature of 4 degrees C to 15 degrees C: Indicated probably deficiency, Contractor to repair as time permits and re-test.

(C) Temperature of 1 degrees C to 3 degrees C: Indicated possible deficiency; Contractor to warrant investigation.

(2) The following absolute temperature tolerances are applied to all components:

(A) Temperature of 40 degrees C or more: Contractor to correct problem immediately and re-test.

(B) Temperature of 21 degrees C to 40 degrees C: Contractor to monitor until corrective measures can be
accomplished. Contractor to re-test after the correction have been accomplished.

(C) Temperature of 11 degrees C to 20 degrees C: Indicated probably deficiency, Contractor to repair as time permits and re-test.

(D) Temperature of 1 degrees C to 10 degrees C: Indicated possible deficiency; Contractor to warrant investigation.

END OF SECTION
PART 1 GENERAL

1.01 DESCRIPTION

A. This Section describes the requirements for furnishing a comprehensive power system study for Broad Creek II WTP from the new Switchgear to new and existing MCC at Broad Creek II WTP and BPS facility.

B. This Section includes general requirements for performing a comprehensive power system study including short circuit analysis, coordination study, and harmonics analysis and testing. The studies shall include all portions of the electrical distribution system from the new Switchgear down to and including the main circuit breakers at the Broad Creek II WTP for the WTP and the WBS MCCs. Although no new electrical work will be performed at WBS facility, data and field testing from these facilities will be required to perform the power system study. Information of the connected loads to WBS will be provided to the Contractor by the County during the construction.

C. The Contractor shall obtain the services of a single independent Power System Analysis Firm (PSA) who shall be responsible for preparing project specific studies and field testing for all components of the power study as specified herein. The PSA shall be regularly engaged in the business of performing short circuit analysis, coordination studies, and harmonics analysis and testing for medium voltage and low voltage power distribution systems.

1.02 QUALITY ASSURANCE

A. References

1. Materials and installation shall be in accordance with the latest revisions of the following codes, standards and specifications, except where more stringent requirements have been specified herein:

   a. Local Building Codes
   b. National Electrical Code - NEC
   c. Underwriters Laboratories, Inc. - UL
   d. Institute of Electrical and Electronic Engineers - IEEE
   e. Insulated Cable Engineers Association - ICEA
   f. American National Standard Institute - ANSI

1.03 SUBMITTALS

A. Submittals shall be submitted in accordance with Section SP-09.

B. Submit a qualifications package for the proposed PSA for this project. The qualifications package shall include the following information which shall be organized and formatted as follows:

   1. Company Background - Provide a brief company overview detailing PSA's experience, capabilities, and available resources. Description of available resources shall include labor categories, staffing, and testing equipment.

   2. Experience in Power Distribution System Evaluations - Provide a list of recent (last 5 years from the bid opening date of this Contract) projects involving Short Circuit, Coordination, and Harmonics Studies and Testing that the has successfully performed.
3. Facilities and Equipment - List type and addition of power system analysis software and testing equipment to be used for this project.

C. Submittal Coordination with Equipment Manufacturers

1. The PSA shall obtain specific submittal information pertaining to proposed power distribution equipment from the Contractor for the proposed equipment manufacturers. This shall include manufacturer's catalog information, equipment ratings, and circuit breaker curves. Reports submitted without the information on proposed power distribution equipment will be rejected. As a minimum, PSA shall obtain equipment information on the following equipment:
   a. Medium and Low Voltage Switchgear
   b. Dry Type Transformers
   c. Panelboards and Circuit Protective Devices
   d. Motor Control Centers
   e. Variable Frequency Drives
   f. Field Mounted Control Panels

D. Power System Study Reports

1. The PSA shall submit Power System Study Reports that shall include the coordination study, short circuit analysis, harmonics analysis, harmonics measurements, and final summary and recommendations. Three separate and distinct submittals as specified herein.

2. Preliminary Power System Study Report
   a. The Preliminary Power System Study Report shall be based on the following information:
      (1) Cables and Conductors
      (2) Transformers
      (3) Panelboards
      (4) Overcurrent Protective Devices
      (5) Packaged Engine Generator Systems
      (6) Surge Suppression Equipment
      (7) Variable Frequency Drives
      (8) Motor Control Centers
   b. The Preliminary Power System Study Report shall be submitted prior to, or with the individual equipment submittals as specified in the individual equipment specifications. The report information will be used by the Engineer to review the equipment submittals for overall approval of the shop drawings. Submission of individual equipment submittals without the preliminary report will not be reviewed and will be returned to the Contractor.
   c. It is the responsibility of the Contractor to forward the proposed electrical equipment submittal information to the PSA prior to submission of the submittals to the engineer for review.
   d. The preliminary report shall consist of the following:
(1) List of proposed power distribution equipment to be provided, with corresponding technical information for equipment pertaining to the study.

(2) Short circuit study evaluation for the proposed power distribution equipment. Provide recommendations for utilization of the proposed equipment based on the adequacy of the short circuit withstand ratings, bus bracing, and overcurrent protective device ratings.

(A) Provide recommendations for mitigating problems with such issues.

(B) Harmonics analysis for the proposed variable frequency drive units. Identify the harmonic voltage/current distortion levels at each point in the system and provide recommendations for mitigating any problems that may arise based on the distortion levels.

(3) Final Power System Study Report - Report shall consist of the following:

(A) All information contained in the final report, with Engineer's comments addressed and incorporated.

(B) Results of field harmonics measurements and testing.

(C) Final summary and recommendations for power distribution system and VFDs.

(D) Report shall be submitted upon completion of the harmonics measurements and testing. Engineer's comments on [mal report shall be addressed, and the [mal report resubmitted, until the final report is provided with an "APPROVED" review code by the Engineer.

(E) Electronic Copies

(F) Submit 2 copies of the electronic files for the [mal Power System Study for future updating and reference by the Owner. Files shall be submitted compact disc in MS Word format.

(G) Arc-Flash Hazard Labels

The PSA shall furnish and install warning labels for all electrical equipment associated with this project.

PART 2 PRODUCTS

2.01 GENERAL

A. The Power System Study shall be provided to evaluate the power distribution system for equipment interrupting capacity, system coordination, system protection, and proper operation within the system limits. The Power System Study shall include the following components:

1. Short Circuit Analysis
2. Coordination Study
3. Arc Flash Hazard Analysis
4. Harmonics Analysis
5. Results of Harmonics Measurements
6. Final Summary and Recommendations

B. The Power System Study shall be performed with the aid of a digital computer program specifically designed for that purpose. Computer programs shall follow the latest applicable IEEE and ANSI standards.

C. Power Distribution System Information and Data
1. The PSA shall obtain utility source information from the power utility.
2. Motor contributions shall be based on motor loads indicated on the Contract Drawings and in the specifications.
3. Utilize the generator impedance value, time constants and current boost data in the study.
4. Cable and conductor impedances may be obtained from standard libraries for equivalent conductors and cables.

2.02 SHORT CIRCUIT ANALYSIS AND COORDINATION STUDY


B. Short Circuit Analysis Parameters
1. The short circuit analysis shall be performed to determine the available (worst case) fault level at critical buses on the distribution system. The basis for the analysis shall be that a “three-phase” bolted fault can occur anytime on any bus in the system.
2. Provide calculation methods and assumptions, base per unit quantities selected, one-line diagrams, source impedance data including power company system characteristics, typical calculations, tabulations of calculated quantities and results.
3. Calculate short-circuit interrupting and momentary (where applicable) duties for an assumed 3-phase bolted fault at each substation, supply switchgear lineup, motor control center, power panelboard, lighting panelboard, and other significant overcurrent protective device locations throughout the system.
4. Provide a ground fault current study for the same system areas, including the associated zero sequence impedance data. Include in tabulations fault impedance, X to R ratios, asymmetry factors, motor fault contribution, short circuit kVA, and symmetrical and asymmetrical fault currents.

C. Coordination Study Parameters
1. Provide a complete short circuit and system protection coordination study of the electrical distribution system with manufacturer’s curves of each protective device indicated on common drawings, to verify proper selectivity and protection for all components of the system obtained. Include all calculations, selected equipment, devices, and recommended settings. The study shall encompass all existing and new devices from the utility connection and the on-site generators to all motor control centers, panelboards, and 480 V field mounted protective devices, including those located in free standing VFD, SSRV and control panels.
2. Provide time-current curves graphically indicating the coordination proposed for the system. Curves shall be provided on full size, log-log forms. Each curve sheet shall be provided with an appropriate title, one line diagram, and identified components or legend. The study shall include coordination curves showing the proposed settings of protective devices required to assure selective coordination. Specific time-current characteristics of each protective device shall be plotted in such a manner that all upstream devices, including utility protective devices, will be clearly depicted on a full-size single log paper sheet.

3. Provide a detailed description of each protective device identifying its type, function, manufacturer, and time-current characteristics. Provide recommended device tap, time dial, pick-up, instantaneous, and time delay settings in a table format.

4. The curve sheets shall include the utility company relay and fuse characteristics, low voltage equipment circuit breaker trip device characteristics, pertinent transformer characteristics, motor and generator characteristics. Devices shall be shown down to the largest branch and feeder circuit breaker in each motor control center and panelboard.

5. Provide adjustable settings for ground fault protective devices.

6. Include manufacturing tolerance and damage bands in plotted fuse characteristics. Transformer full load currents, magnetizing inrush, ANSI transformer withstand ratings, and significant symmetrical fault currents shall be included on the curves. Terminate device characteristic curves at a point reflecting the maximum symmetrical fault current to which the device is exposed.

7. Provide phase and ground coordination for the generator protective devices. Show the generator decrement curve and damage curve along with the operating characteristic of the protective devices. The PSA shall utilize the actual generator impedance value, time constants, and current boost data in the study.

2.03 HARMONICS ANALYSIS

A. The PSA shall evaluate the estimated harmonic distortion levels for the power distribution system. Simulate via computer modeling the power distribution system with harmonic generating devices including variable frequency drives (VFDs), uninterruptible power supplies (UPS), and other significant harmonic generating equipment.

B. Perform frequency scans (2nd to 50th harmonics) to determine the frequency response characteristics looking at each of the selected busses described in Part 3.03 of this specification.

C. Provide computer simulation results including a spectrum of individual harmonic levels, bus voltage distortion levels, and current distortion levels. The results shall be evaluated based on the recommended limits outlined in IEEE Standard 519-1992.

D. Harmonics analysis shall be performed using recognized harmonic analysis computer programs. The VFD and UPS equipment parameters and specifications proposed for this project shall be input to the computer programs.

E. The final simulations shall be used to develop solutions to any potential harmonic problems. The PSA shall provide recommendations for solutions to eliminate any problem associated with harmonics to bring the system into compliance with the harmonic distortion limits recommended in IEEE 519-1992.

F. The final simulation results shall be compared to the field measurements taken during operation of the equipment as described in Paragraph 3.04 of this specification, with corresponding final summary and recommendations included in the final report.
2.04 REPORT

A. A comprehensive report shall be prepared to document each component of the Power System Study. The report shall be clearly organized and provided with tab dividers to separate logical sections. The report shall include the following information as a minimum:

1. General Description:
   a. Provide a general description outlining the purpose of the report. The general description shall include a basis and scope for the limits of the study.

2. Short Circuit Analysis
   a. Describe the parameters which have an impact on the analysis in explicit detail.
   b. Compare the manufacturer’s published interrupting, withstand and bus bracing ratings with the calculated available fault levels.
   c. Summarize any system deficiencies or shortcomings with the interrupting capability of the proposed distribution equipment.
   d. Provide recommendations and solutions for correcting any deficiencies.

3. Coordination Study
   a. The study shall include performing time-current analysis of each protective device.
   b. The PSA shall provide recommendations for setting and adjusting the protective relay and circuit breaker settings and parameters to assure proper equipment and personnel protection.
   c. Provide conclusions based on the compiled information, and recommendations for modifications to equipment or systems to correct any deficiencies.

4. Arc Flash Hazard Analysis
   a. The Report shall include an Incident Energy Study performed in accordance with the IEEE 1584-2004a, "IEEE Guide for Performing Arc Flash Hazard Calculations" as referenced in NFP A 70, "Standard for Electrical Safety in the Workplace", latest Revision, in order to quantify the hazard for selection of personal protective equipment (PPE). Tables that assume fault current levels and clearing time for proper PPE selection are not acceptable.
   b. Report shall include incident energy level (calories/cm²) for each equipment location and recommended PPE.
   c. The PSA shall optimize the results of the study as it relates to safety and reliable electrical system operation (e.g. overcurrent device settings, working distances, current limiting devices). This includes mitigation, where possible, of incident energy levels that exceed 40 calories/cm².

5. Harmonics Analysis
   a. The study shall include harmonic distortion analysis for voltage and current predicated at the VFD input terminations, UPS input terminations and upstream equipment busses as specified herein.
   b. Identify magnitude of harmonic voltage and current distortion including individual harmonics up to and including the 50th, total harmonic
distortion (THD) on the system, as well as de-rating factors affecting equipment.


6. Existing Equipment Information

a. The preliminary report shall contain information on existing electrical distribution equipment.

7. Final Summary and Recommendations

a. Provide a final summary of all findings, and final recommendations, based on field measurements taken, and analyses performed.

8. Appendices

a. Provide computer input and output databases used in the evaluations.

b. Provide one or more comprehensive one-line diagrams for the power distribution system. Components shall be specifically labeled with tags and values which correlate to referenced items noted in the studies.

c. Provide an equivalent impedance one-line diagram for the power distribution system. Components shall be specifically labeled with tags and impedance values which correlate to referenced items noted in the studies.

d. Provide field data for harmonic values obtained while conducting field measurement surveys.

e. Provide field data for power measurement values obtained while conducting field measurement surveys.

2.05 ARC-FLASH HARD LABELS

A. Based on the results of the incident energy study, the supplier shall produce and install warning labels (orange < 40 call/cm\(^2\)) or danger label (red >40 call/cm\(^2\)) for each piece of equipment in accordance with ANSI Z535.4-2002. The label must be readable in both indoor and outdoor environments for at least 3 years and contain the following information:

1. Arc hazard boundary (inches)
2. Working distance (inches)
3. Arc flash incident energy at the working distance (calories/cm\(^2\))
4. PPE category and description including the glove rating
5. Voltage rating of the equipment
6. Limited approach distance (inches)
7. Restricted approach distance (inches)
8. Prohibited approach distance (inches)
9. Equipment/bus name
10. Date prepared
11. PSA name and address
PART 3 EXECUTION

3.01 GENERAL

A. Power distribution equipment shall not be energized prior to adjusting and setting all of the relay protective devices in accordance with approval of the pre-final Power System Study Report.

3.02 DATA COLLECTION

A. Existing Equipment

1. Perform a site survey of the existing electrical distribution system in order to collect comprehensive data necessary for the power system study. Obtain field data and equipment nameplate information for the existing equipment which will remain as part of the power distribution system. Obtain type, length, and size information for existing feeders. Survey information shall be submitted as part of the preliminary power system study report.

B. Utility Information

1. Short-circuit currents or impedances available from the electric utility system supplying the new power distribution system, and time-current characteristics and the settings of the utility protective devices on the supply side of the feeders shall be requested from the electric utility by the PSA.

C. Equipment Submittals and Technical Information

1. The PSA shall obtain equipment submittal information and technical information for the power distribution equipment and VFDs proposed for the project.

3.03 FIELD CALIBRATION

A. The PSA shall supervise the performance of the on-site field adjustments for the protective relays, devices, and adjustable circuit breaker settings. The settings shall be adjusted in accordance with the final Power System Study Report.

B. The on-site field adjustments shall be supervised by a power systems technician who shall be present, on-site, as required to set and calibrate each power distribution unit. This Contractor shall coordinate the number of site trips required for the PSA with the sequencing of the installation and startup of the associated equipment. The technician shall be present on-site for a minimum of 16 hours (excluding travel time) for installation assistance, inspection, and certification of the installation.

3.04 HARMONICS MEASUREMENTS AND TESTING

A. Field measurements shall be performed in the presence of the Engineer's Representative. The PSA shall furnish all materials, labor, and equipment necessary to conduct field measurements. The PSA shall maintain a written record of all measurements, which includes date, test performed, personnel involved, devices tested, serial number and name of test equipment, and measurement results in the form of an analysis report described below.

B. The PSA shall perform on-site field services and data collection to obtain harmonic measurements (voltage and current harmonic levels) and power measurements (real power, kW and reactive power kVAR) for the distribution system. Measurements shall be taken at the following busses as a minimum.

1. Low Voltage side of pad mounted transformers.
2. 480V motor control centers and panelboards.
3. 480V variable frequency drives (input terminal connections, including MCC mounted VFDs)

C. The PSA shall note specific conditions at the time the measurements are taken, including motor status, motor speed, loading levels. Snapshots of measurements shall be taken for VFDs rated 10 Hp and larger. Power measurements shall be compared to values provided by the digital power meters and digital power monitors located on the equipment.

D. Harmonic measurements shall be taken for the worst case system configurations and load schemes. The PSA shall coordinate scheduling of the work with the Contractor in order to test the system with all equipment in operation. The Contractor shall make arrangements to schedule all monitoring work in order to not adversely effect the treatment plant testing.

E. Results of the harmonic field measurements shall include a spectrum of individual harmonic levels, voltage distortion levels and current distortion levels at each of the selected buses. Provide tabulated results similar to IEEE-519, 1992, Appendix 4.9, Table 13.2 and Appendix 4.10, Table 13.3 and plotted results similar to IEEE-519, 1992, Appendix 4.8, Figure 9.1 and Figure 9.2. Results of power factor field measurements shall be tabulated.

F. Field measurements shall be collected using a power and harmonic analyzer.
SECTION 16051
MISCELLANEOUS ELECTRICAL DEVICES

PART 1 GENERAL

1.01 DESCRIPTION
A. This section includes materials and installation of miscellaneous electrical devices and equipment, such as disconnect switches, pushbuttons, selector switches, indicating lights, limit switches, and control relays.

1.02 RELATED WORK SPECIFIED ELSEWHERE
A. General Electrical Requirements: 16010

1.03 SUBMITTALS
A. Submit shop drawings in accordance with Section SP-09.
B. Submit ratings and characteristics including voltage ratings, continuous current ratings, conduit entry restrictions, and enclosure type and dimensions.

PART 2 MATERIALS

2.01 DISCONNECT SWITCHES
A. Provide nonfusible or fusible disconnect switches with ampere rating and number of poles as indicated in the drawings. Switches shall be NEMA heavy-duty Type HD. Mechanisms shall have quick-make and quick-break operating handles and provisions for padlocking in the “OFF” position. The switch shall have an interlock to prevent unauthorized opening of the hinged cover when the switch is in the “ON” position and an interlock to prevent closing the switch mechanism with the hinged cover open. Fusible switches shall be equipped with rejection feature. Switch contacts shall be silver or tinned plated. On the front of the enclosure, attach a nameplate that identifies the load per Section 16010. Disconnect switches shall be Square D, or equal.
B. Provide disconnect switches in NEMA 7 enclosures in Class I, Division 1 and Class I, Division 2 hazardous locations.

2.02 PUSHBUTTONS, SELECTOR SWITCHES, AND INDICATING LIGHTS
A. Remote-mounted pushbuttons, selector switches, and indicating lights shall be heavy duty, oiltight type, 30.5 mm with NEMA rating as required by Section 16010. Indicating lights shall be push to test type.
B. Install provisions for locking pushbuttons and selector switches in the OFF position wherever lockout provisions are indicated. Stop pushbuttons shall be maintained.
C. Provide Allen-Bradley Bulletin 800H; Square D Class 9001, Type SK; or equal.
D. Provide control stations in NEMA 7 enclosures in Class I, Division 1 and Class I, Division 2 hazardous locations.

2.03 LIMIT SWITCHES
A. Provide heavy-duty, precision turret head type limit switches with one normally open and one normally closed contact along with an adjustable lever arm with oil-impregnated sintered iron roller, unless otherwise noted. The normal condition of the switch shall be a closed contact.
B. Provide a Square D, Class 9006, Type C switch or equal.
C. Provide type NEMA 7 limit switches in Class I, Division 1 and Class I, Division 2 hazardous locations.
PART 3 EXECUTION

3.01 MOUNTING BRACKETS
   A. Provide standoff brackets providing a minimum of 1-1/2-inch air space between the
device and the mounting surface. Provide 304 stainless steel brackets and concrete
anchors in all locations.

3.02 TESTING
   A. Operate each disconnect switch under load, and verify that all phases of the load are
disconnected each time.
   B. Operate each push button, selector switch, and limit switch to verify that the equipment
controlled operates per the plans or other sections of these specifications.
   C. Verify the operation of each pilot light.

END OF SECTION
SECTION 16110
RACEWAYS, BOXES, AND FITTINGS

PART 1 GENERAL

1.01 DESCRIPTION
A. This section describes materials and installation of raceway systems, whether concealed or exposed, above or below grade.

1.02 RELATED WORK SPECIFIED ELSEWHERE
A. General Electrical Requirements: 16010
B. Wire and Cables: 16120

1.03 SUBMITTALS
A. Submit shop drawings in accordance with Section SP-09.
B. Submit material list for all conduits, fittings, boxes, conduit bodies, mounting hardware, and related accessories.
C. Submit scaled, accurate conduit layout drawings for each building, facility, vault, and for the site.

PART 2 PRODUCTS

2.01 RIGID STEEL CONDUIT AND FITTINGS
A. Use rigid, thick wall, hot-dipped galvanized inside and out, with galvanized threads conforming to ANSI C80.1 and UL-6. Do not use electrogalvanizing.
B. Use insulated metallic bushings. Sizes 1 inch and smaller may be nonmetallic type.
C. Use hot-dipped galvanized threaded fittings which are compatible with the conduit.
D. Use cast aluminum or hot-dipped galvanized cast-iron conduit bodies, equipped with threaded covers or gasketed sheet metal covers secured with at least two captive screws.

2.02 RIGID NONMETALLIC CONDUIT AND FITTINGS
A. Polyvinyl chloride (PVC) Schedule 40, 90 C rise rating. Conduit shall conform to NEMA TC-2 and UL-651.

2.03 PVC-COATED CONDUIT AND FITTINGS
A. PVC-coated conduit and fittings shall be rigid galvanized steel with a .040-inch-minimum thickness of PVC coating. Interior coating shall be 2-mil urethane. Conduit and fittings shall be UL listed and shall conform to ANSI C80.1 and to UL-6. Conduit and fittings shall be Permecote Supreme or equivalent product of Occidental or Robroy.

2.04 LIQUID-TIGHT FLEXIBLE CONDUIT AND CONNECTORS
A. Use single strip steel, hot-dipped galvanized on all four sides prior to conduit fabrication. Conduit shall have overall PVC plastic jacket. Conduit sizes 1-1/4 inches and smaller shall include an integral copper bonding conductor wound spirally in the space between each convolution on the inside of the conduit. Conform to UL-360.
B. Use compression type bushings with steel or malleable iron body and insulated throat and sealing o-ring.
C. All fittings shall be PVC coated.

2.05 FLEXIBLE CONDUIT AND CONNECTORS
A. Use single strip steel, hot-dipped galvanized on all four sides prior to conduit fabrication. Conform to UL-1.

2.06 WIREWAY

A. Oil-tight, dust-tight, watertight wireway (NEMA 3R) shall conform to UL 870, and shall not be less than 14-gauge 304 stainless steel except that end flanges shall not be less than 10 gauge 304 stainless steel. Wireways shall be gasketed and provided with quick release screw clamps.

B. Oil-tight, dust-tight wireway (NEMA 12) shall conform to UL 870, and shall not be less than 14-gauge steel, except that end flanges shall not be less than 10-gauge steel. Wireway shall be constructed without knockout, and shall be provided with corrosion-resistant phosphatizing primer and ANSI-49 grey epoxy finish. Wireway shall be gasketed and provided with quick release cover latches.

C. Wireways can be fabricated by J.M. Gillin Corp or equal.

2.07 OUTLET, JUNCTION, AND PULL BOXES

A. Provide boxes for installation of electrical work, in compliance with codes and regulations.

B. Provide one-piece galvanized pressed steel knockout-type boxes, nominal sizes 4 inches square by 1-1/2 inches in flush-mounted or concealed locations above suspended ceilings unless otherwise indicated. Boxes for use in concrete shall have square corner tile type covers with ribs or extensions for casting in concrete.

C. Construct pull boxes in flush-mounted or concealed locations that are larger than 4 inches square by 1-1/2 inches of code-gauge sheet steel finished with one coat of metal primer and one coat of primer sealer.

D. Use PVC coated threaded-hub ferrous boxes for surface-mounted or exposed locations. PVC coated cast conduit fittings may be used instead of boxes except where boxes contain devices.

E. Where threaded-hub cast boxes and fittings are not practical, provide NEMA 4X pull boxes constructed of Type 304 stainless steel. Install cover with neoprene gaskets and Type 304 stainless steel bolts. Attach conduit with “Myers” hubs.

2.08 MANHOLES AND HANDHOLES

A. Manholes shall be precast per ASTM C 478 with 28-day, 3000-psi minimum compressive strength concrete and designed for AASHTO H-20 loading. Manholes shall have minimum interior dimensions as shown on drawings with a concrete throat to the surface. Provide a drainage outlet at the low point of the floor constructed with a cast-iron, slotted or perforated hinged cover, and a 4-inch minimum outlet and outlet pipe. Set manholes on a crushed rock base 12 inches thick with horizontal dimensions same as bottom of manhole plus 6 inches all around.

B. Handholes shall be electrical-type utility boxes manufactured by Quickset, Brooks Products, or equal. Handhole minimum interior size shall be as shown on drawings with 6 inch thick concrete walls and cover. Provide handholes with concrete bolt down covers in unpaved areas and handholes with cast-iron covers with bolt downs and lifting hook in paved areas. Set the handhole on a crushed rock base 6 inches thick with horizontal dimensions same as bottom of handhole plus 6 inches all around. Crushed rock shall be 3/4 inch maximum size.

C. Provide raceway entrances on all four side. For raceways installed under this contract, knockout panels or precast individual raceway openings may be used. On sides where no raceways are installed under this contract, provide 12-inch-high by 24-inch-wide (minimum) knockout panels for future raceway installation.
D. Utilize frames and covers made of cast iron, suitable for street loading. On the upper side of each cover, cast in integral letters not less than 2 inches high appropriate titles, ELECTRIC HV (for above 600 volts), ELECTRIC LV (for 600 volts and below), or CONTROL. Field stamp covers with manhole or handhole numbers indicated on the drawings. Cover shall be minimum 36” diameter.

E. Provide cable racks with adjustable arms and insulators for cables in each manhole. Set adjustable inserts in the concrete walls for the attachment of racks. Do not use bolts or studs embedded in concrete for attaching racks. Set racks and inserts not greater than 3-foot centers around the entire inside perimeter of the manhole, arranged so that spare conduit ends are clear for future cable installation. Provide racks with arms and insulators to accommodate cables for each conduit entering or leaving the manhole including spares.

F. Provide a pulling iron embedded in the concrete wall or flush with the concrete floor opposite each raceway entrance and one in the floor vertically below the center of the manhole cover. Utilize ¾-inch-round stock securely fastened to the overall steel reinforcement before concrete is poured.

G. Provide an aluminum ladder with square rungs permanently mounted within the manhole. Rungs shall have serrated non-skid tops.

H. Concrete pull boxes, handholes and vaults shall be precast with pull-in irons, hot-dipped galvanized traffic cover with hot-dipped galvanized frame, and two galvanized cable racks with porcelain blocks on each of the two longest sides. Design for AASHTO H-20 loading. Provide bead weld on cover of pull box to indicate services within pull box (electrical, telephone, fire alarm, signal). After cables have been pulled and inspected, seal box between cover and frame with a mastic compound similar to Parmagum, Dukaseal, or equal.

I. Manufacturers: Brooks Products, Inc.; Penn-Cast Products, Inc.; Concrete Conduit Company; Associated Concrete Products, Inc.; or equal.

2.09 HAZARDOUS LOCATIONS

A. Conform with NEC Articles 501 and 502 for areas identified as “Hazardous Areas” in the specifications and on the drawings.

B. Provide threaded cast boxes and fittings for junction boxes and pull boxes in Class I and Class II areas. Boxes and fittings shall conform with Class I, Groups A, B, C, and D and Class II, Groups E, F, and G requirements.

C. Fixture hangers for pendant-mounted fixtures shall conform with Class I, Division 1 and Class II, Division 1 requirements.

D. Provide conduit seals in Class I, Division 1 and Class I, Division 2 locations within 18 inches of each conduit entering an enclosure containing electrical devices except for hermetically sealed switches and receptacles. Provide a conduit seal for each conduit leaving the hazardous location.

E. Flexible connections to motors and other vibrating equipment in Class I, Division 1 locations shall be made with flexible fittings approved for Class I, Division 1 locations.

2.10 CONCRETE-ENCASED DUCT BANKS

A. Concrete shall be Class C with red color additive in accordance with Section 03300.

PART 3 EXECUTION

3.01 CONDUIT USAGE

A. Install the following types of raceway in the locations listed, unless otherwise indicated on the drawings.
1. Exterior, Exposed:
   a. PVC-coated rigid galvanized steel conduit.

2. Interior, Exposed:
   a. PVC-coated rigid galvanized steel conduit.

3. Embedded in Concrete or Masonry:
   a. Rigid non-metallic conduit

4. Underground Direct Burial, or Below Concrete Slabs:
   a. PVC-coated rigid galvanized steel conduit

5. Underground Concrete Encased:
   a. Provide rigid nonmetallic conduit. Provide rigid steel conduit long radius elbows for bends exceeding 45 degrees (see requirement for conduit stub-ups) or
   b. Rigid steel conduit (see requirement for conduit stub-ups).


9. All fittings for conduit or enclosures which are connected to PVC coated conduit or fittings shall be PVC coated.

10. The Contractor shall replace all PVC coated conduit and fittings which have damaged, nicked, or scared PVC coating, at no cost to the County. A repair system will not be acceptable.

3.02 CONDUIT INSTALLATION

A. Conduit runs are shown schematically. Supports, pull boxes, junction boxes, and other ancillary equipment are not usually shown. Provide pull boxes and junction boxes where shown. In addition, provide pull boxes and junction boxes to permit pulling of wires without damage to the conductors or insulation.

B. Install exposed conduits parallel to or at right angles to the lines of the building. Make right-angle bends in exposed conduit runs with standard elbows, threaded conduit fittings, or conduit bent to radii not less than those of standard elbows.

C. Route exposed conduit to preserve headroom, access space, and work space.

D. Conduit in Concrete Slabs: Run conduits 2 inches clear from face of slab and 3 inches clear between other conduits.

E. Do not route conduits below or within concrete footings except to cross footing at 90-degree angles.

F. Conduit in Concrete Walls: Run conduits in center of wall and 4 inches vertical clearance between other conduits.

G. Provide expansion fittings for raceways crossing expansion joints in structures or concrete slabs.

H. Treat threaded joints of rigid steel conduit with T&B “Kopr-Shield” before installing fittings where conduit is in slabs and other damp or corrosive areas.
I. Terminate rigid Steel and Aluminum conduits with locknuts and bushings. Install conduit squarely and provide one locknut outside the box and a bushing inside the box. Install locknuts with dished side against the box.

J. When terminating in threaded hubs, screw the conduit or fitting tight into the hub so that the end bears against the fire protection shoulder. When chase nipples are used, install the raceway and coupling square to the box and tighten the chase nipple with no exposed threads.

K. All conduits shall enter exterior pullboxes, control panels, junction boxes, and all other enclosures from the bottom. No top entries allowed without prior approval by the County.

L. Provide minimum 12” separation of conduits with twisted shielded pair analog signal wiring and conduits with power circuits.

M. Do not route conduit or install junction boxes in sump, containment or other areas subject to submerging conduits and fittings.

3.03 WIREWAY

A. Provide NEMA 3R stainless steel for outdoor applications.

B. Provide NEMA 12 for indoor dry applications.

C. Separate and identify 480 VAC and 120 VAC conductors.

3.04 DUCT BANKS AND CONCRETE ENCASEMENTS

A. Provide 30-inch-minimum cover for direct burial underground conduit. Provide 4-inch minimum sand above and below conduit. Underground conduits shall be direct buried unless identified as concrete encased on the drawings, or as specified herein.

B. Provide 30-inch-minimum cover above top of concrete for concrete-encased duct banks. Provide 4-inch-minimum separation between conduits and 4-inch-minimumm concrete encasement around conduits. Extend the concrete encasement under any floor slabs or equipment mounting pads to the point of raceway termination.

C. All conduits installed under traffic areas shall be concrete encased. This includes all asphalt, gravel, concrete, and other areas where vehicular traffic occurs.

D. Where other utility piping systems are encountered or being installed along a raceway route, maintain a 12-inch-minimum separation between raceways and other systems in parallel runs. Do not place raceways over valves or couplings in other piping systems. Refer conflicts with these requirements to the County’s Representative for instructions before further work is done.

E. Maintain a grade of at least 4 inches per 100 feet either from one manhole or pull box to the next or from a high point between them, depending on the surface contour. Slope ducts from buildings to pull boxes, handholes, or manholes.

F. Changes in direction of over 10 degrees shall be with long sweep bends with minimum radii of 10 feet. Manufactured bends may be used at manholes or pull boxes for runs under 100 feet. Minimum radii of conduit under 3 inches shall be 18 inches. For conduit 3 inches and larger, minimum radii shall be 36 inches.

G. Thoroughly clean conduits before laying. During construction and after completion, the conduit ends shall be kept plugged to prevent water from washing mud into the manholes, handholes, or pull boxes.

H. Terminate conduit in end bells in manholes, handholes, and pull boxes and enter at right angles to the wall.

I. Place separators every 4 feet on center and securely anchor to prevent movement.

3.05 CONDUIT SUPPORTS

Project No: W804000  16110-5  1217/2010

Project Name: Broad Creek II Water Treatment Plant
A. Support conduit at intervals and at locations as required by the NEC. Do not use perforated strap or plumbers tape for conduit supports.

B. Above suspended ceilings, support conduit on or from the structure except that individual conduits of 1 inch or smaller size may be supported from the suspension wires (using “caddy” spring steel fasteners) or from the ceiling channels (using 16-gauge galvanized annealed tie wire). Support conduit attached to the suspension system at maximum 4-foot intervals.

C. Conduit on Concrete or Masonry: Use one-hole malleable iron clamps with pipe spacers (clamp backs) or preformed galvanized steel channels. Anchor with metallic expansion anchors and screws or from preset inserts. Use preset inserts in prestressed concrete. On plaster or stucco, use one-hole malleable iron straps with toggle bolts. For PVC coated conduit use PVC coated clamps and spacers.

D. Suspended Conduit: Use Type 304 stainless-steel pipe hangers with Type 304 stainless-steel threaded suspension rods sized for the weight to be carried (minimum 3/8 inch diameter); Unistrut, Kin-Line, or equal. For grouped conduits, construct racks with Type 304 stainless-steel rods and 6063-T6 extruded aluminum preformed channel cross members. Construct channel to limit deflection to 1/200 of span. Conduit clamps shall be aluminum. Provide Type 304 stainless-steel bolts and nuts.

E. Supports at Structural Steel members use type 304 stainless-steel beam clamps. Drilling or welding may be used only where indicated on the drawings.

F. Wherever conduit may be affected by dissimilar movements of the supporting structures or medium, provide flexible or expansion devices.

3.06 CONDUIT PENETRATIONS

A. Dry-pack with nonshrink grout around raceways that penetrate concrete walls, floors, or ceilings above ground, in addition to paragraphs B. and C.

B. Where an underground concrete ductbank enters a structure through a concrete roof or a membrane waterproofed wall or floor, provide a malleable waterproofed wall or floor watertight, entrance sealing device. When there is no raceway concrete encasement specified or indicated, provide such a device having a gland-type sealing assembly at each end with pressure bushings which may be tightened at any time. When there is raceway concrete encasement specified or indicated provide such a device with a gland-type sealing assembly on the accessible side. Securely anchor all such devices into the masonry construction with one or more integral flanges. Secure membrane waterproofing to such devices in a permanently watertight manner.

C. Where an underground raceway without concrete encasement enters a structure through a wall or floor, install a watertight entrance sealing device, such as Linkseal.

3.07 WARNING TAPES

A. Bury warning tapes above all underground direct buried and concrete-encased conduits and duct banks. Align parallel to and within 3 inches of the centerline of the conduit or duct bank.

B. Plastic tape shall be yellow, 3-inch minimum width. Utilize tape made of material resistant to corrosive soil. Use tape with printed warning that an electric circuit is located below the tape. Manufacturers and types: ITT Blackburn Type YT, Griffolyn Co., Terra-Tape, or equal.

3.08 MANHOLES, HANDHOLES AND PULL BOXES

A. Install per Division 3.
B. Install covers flush with finished paved surfaces. In unpaved areas, install the top of manhole or pull box covers 1 inch above finished grade or 6 inches above unfinished grade.

C. Securely support cables on manhole or pull box walls by cable racks, support arms, brackets, and insulators.

D. At each manhole, handhole, and pull box, at a convenient location close to a wall, provide a ¾ - inch by 10 foot ground rod driven with 6 inches of rod exposed. Provide a watertight seal. Grounding and bonding shall be per Section 16450.

E. Excavation, backfilling, and grading shall conform to requirements of Division 2.

F. Use box extension sections where necessary to raise cover to height required depending on grade finish.

3.09 DAMAGED CONDUIT

A. Replace conduit damaged during or after installation. Replace crushed or clogged conduit or any conduit whose inner surface is damaged or not smooth.

B. Repair cuts, nicks, or abrasions, in the zinc coating of galvanized conduit with galvanizing repair stick, Enterprise Galvanizing “Galvabra” or equal.

3.10 MANDREL

A. For raceways in concrete-encased duct banks, after the concrete envelope has set, pull a mandrel of a diameter approximately ¼ inch less than the raceway inside diameter, through each raceway. Then pull a bristle brush through each raceway to remove debris.

3.11 PULL CORD

A. Provide 200-pound strength nylon pull cord in all used and empty conduits.

3.12 PULL BOXES

A. Support wall-mounted pull boxes and panels in all locations with Type 304 stainless-steel preformed channels and Type 304 stainless-steel concrete anchors.

3.13 TESTING

A. None required.

END OF SECTION
SECTION 16120
WIRES AND CABLES

PART 1 GENERAL
1.01 DESCRIPTION
   A. This section describes materials and installation of wires and cables.

1.02 RELATED WORK SPECIFIED ELSEWHERE
   A. General Electrical Requirements: 16010
   B. Raceway, Boxes, & Fittings: 16110
   C. Fiber-Optic Cable: 16125

1.03 SUBMITTALS
   A. Submit shop drawings in accordance with Section SP-09.
   B. Submit material list for each conductor type. Indicate insulation material, conductor material, voltage rating, manufacturer and other data pertinent to the specific cable, such as type shielding, number of pairs, and applicable standards.

PART 2 MATERIALS
2.01 LOW-VOLTAGE BUILDING WIRE
   A. Conductor material shall be copper.
   B. Low-voltage building wire for use at 600 volts or less shall be 600-volt insulated, Type THWN, and rated for continuous operation at 75°C.
   C. In underground conduits and ductbanks, utilize type XHHW, 75°C, 600 volt conductors.
   D. No. 12 AWG minimum conductor size for power and lighting circuits.
   E. No. 14 AWG minimum conductor size for control circuits.
   F. All conductors shall be stranded.

2.02 INSTRUMENT CABLE
   A. Single-pair cables shall be two No. 18 AWG stranded tinned-copper conductors individually insulated with fully color-coded PVC rated at 600 volts; insulated conductors twisted together and shielded with a spiral-wound metal foil tape overlapped for 100% shielding. Outer jacket shall be PVC.
   B. Multiple-pair cables shall have number of pairs specified with each pair being two No. 18 AWG stranded tinned-copper conductors individually insulated with PVC rated at 600 volts. Conductor pairs shall have insulation pigmented black and white with white conductor numerically printed for group identification. Each pair and its 20 AWG stranded tinned-copper drain wire shall be twisted together and shielded with an aluminum-polyester tape overlapped for 100% shielding. Provide a cable shield of 2.35-mil aluminum-polyester tape overlapped to provide 100% shielding and an 18 AWG copper drain wire. Provide a flame-retardant PVC jacket per UL 13, 105°C temperature rating.

2.03 NETWORK CABLE
   A. Provide Category 5e shielded plenum rated network cabling. The cable shall be solid 24 AWG conductor, 4 pair, unshielded type. Provide cable with jacket. Cable shall be suitable for 100 Mbps communications. Provide Belden, or equal.
B. Provide RJ-45 jack outlets for connecting equipment to the Ethernet network. Each jack shall be wired to an 8-position terminal strip for connection of the Category 5 cable.

C. Provide cabling, couplers, end connectors, T-connectors, terminators, junction boxes and all other associated cable connectors as required for supplying a complete and fully integrated system for each of the communication networks, and as required by the manufacturer.

### PART 3 EXECUTION

#### 3.01 WIRE INSTALLATION

A. Install wiring and cable in conduit unless otherwise noted.

B. To reduce pulling tension in long runs, coat cables with pulling compound recommended by the cable manufacturer before being pulled into conduits.

C. Remove debris and moisture from the conduits, boxes, and cabinets prior to cable installation.

D. Group conductors No. 1/0 and smaller in panelboards, cabinets, pull boxes, and switchboard wireways; tie with plastic ties; and fan out to terminals. Lace conductors No. 2/0 and larger with marline.

#### 3.02 IDENTIFICATION

A. Color coding of Low-Voltage Building Wire: Provide color coding throughout the entire network of feeders and circuits (600 volts and below) as follows:

<table>
<thead>
<tr>
<th>Phase</th>
<th>208/120Volts</th>
<th>480/277 Volts</th>
<th>240Volts</th>
<th>240/120Volts</th>
</tr>
</thead>
<tbody>
<tr>
<td>Phase A</td>
<td>Black</td>
<td>Brown</td>
<td>Black</td>
<td>Black</td>
</tr>
<tr>
<td>Phase B</td>
<td>Red</td>
<td>Orange</td>
<td>Red</td>
<td>Red</td>
</tr>
<tr>
<td>Phase C</td>
<td>Blue</td>
<td>Yellow</td>
<td>Blue</td>
<td></td>
</tr>
<tr>
<td>Neutral</td>
<td>White</td>
<td>Gray</td>
<td>White</td>
<td>White</td>
</tr>
<tr>
<td>Ground</td>
<td>Green</td>
<td>Green</td>
<td>Green</td>
<td>Green</td>
</tr>
</tbody>
</table>

B. Conductions No. 10 AWG and smaller shall have factory color coding with solid color insulation. Do not use onsite coloring of ends of conductors or apply colored plastic adhesives in lieu of factory color coding.

C. Conductions No. 8 AWG and larger shall have factory color coding with solid color insulation or shall have black insulation with onsite application of colored plastic adhesives at ends of conductors and at each splice.

D. Control wires shall have colored insulation. Control wiring coloring shall be same as specified in Section 16946.2.06.

E. Tagging of Conductors: Tag control wires and instrument cables in panels, pull boxes, wireways, and at each control device with adhesive type of marker: Brady, Thomas and Betts, or equal. Tag control wires and instrument cables with same wire numbers as on the shop drawing submittals. Tag power wires in pull boxes and wireways where there is
more than one circuit. Tag power conductors with motor control center or panelboard number and circuit numbers.

3.03 LOW-VOLTAGE WIRE SPLICES

A. Solid Conductors: Use 3M “Scotchlok,” Ideal “Super Nut,” Buchanan B-Cap, or equal. Seal splices in underground handholes and pull boxes and in light poles with individual sealing packs of Scotchcast Brand 400 Resin or equal.

B. Stranded Conductors No. 8 and Larger: Use T & B “Locktite” connectors, Burndy Versitaps and heavy-duty connectors, O.Z. solderless connectors, or equal.

C. Stranded Conductors No. 10 and Smaller: Use crimp connectors with tools by same manufacturer and/or UL listed for connectors of all stranded conductors.

D. Retighten bolt-type connectors 24 to 48 hours after initial installation and before taping. Tape connections made with noninsulated-type connectors with rubber-type tape, one and one-half times the thickness of the conductor insulation, then cover with Scotch 33 tape.

3.04 Do not splice cables unless specific concurrence is obtained from the Owner’s Representative. Make splices and terminations in accordance with the splice or termination manufacturer’s instructions.

3.05 TESTING

A. Insulation Resistance Tests

1. Test each complete power and digital control circuit prior to energizing. Insulation resistance between conductors and between each conductor and ground shall not be less than 25 megohms. Repair or replace wires or cables in circuits which do not pass this test and repeat the test.
PART 1 GENERAL

1.01 DESCRIPTION
A. This section includes materials, installation, and testing a buried single mode fiber-optic cable-in-duct system for use in long distance telemetry service.

1.02 RELATED WORK SPECIFIED ELSEWHERE
A. General Electrical Requirements: 16010
B. Raceways, Boxes, and Fittings: 16110.

1.03 SUBMITTALS
A. Submit shop drawings in accordance with Section SP-09.
B. Submit catalog data on the fiber-optic cable, in-duct, pull boxes, connectors, conduit sealant, closures, enclosures, identification tape, and mounting hardware.
C. Submit catalog data and installation instructions on the splice method, hardware, and splicing equipment.
D. Submit detailed bill of materials.
E. Submit catalog data on the testing equipment. Submit a written test procedure outlining the steps and methods that will be used to test the cable before and after installation. Include a sample copy of the test form that will be used in the test procedure.
F. Provide a cable and duct installation procedure outlining the construction methods that will be used. Identify steps that will be taken to ensure that the cable is not damaged during the installation.
G. Submit complete factory test results for each cable reel stating the signal loss for each fiber in the cable.
H. Submit record drawings indicating the locations of all splices and pull boxes with station numbers.

1.04 QUALIFICATIONS AND RESPONSIBILITY OF INSTALLER
A. The fiber-optic system shall be the unit responsibility of the contractor, however, all coordination shall be through the system supplier as specified in Section 16900.
B. Submit evidence of qualification and experience in installing fiber-optic cables in writing. The qualification evidence shall include the following:
   1. Written evidence that the system installer has a minimum of three years’ experience with the installation of fiber-optic systems similar to this project.
   2. A list of completed installations similar to this project including the name and address of the Owner, the name of the project, and the date or completion.
   3. The name and qualifications of the supervisory personnel that will be directly responsible for the installation of the fiber-optic system.

1.05 FIELD CONTROL OF LOCATION AND ARRANGEMENT
A. The drawings diagrammatically indicate the desired location and arrangement of pull boxes, cable runs, and other items. Exact locations shall be determined by the Contractor in the field based on the physical size and arrangement of equipment, finished
elevations, and obstructions. Locations shown in the drawings, however, shall be adhered to as closely as possible.

PART 2 MATERIALS

2.01 FIBER-OPTIC CABLE

A. The fiber-optic cable shall be a multi-mode cable suitable for use with both 850 and 1,300 nm transmission equipment. The cable sheathing shall be medium-density polyethylene (MDPE). The cable shall be all dielectric.

B. Each fiber shall consist of a 62.5-micron core with a 125-micron cladding and a coating diameter of 250 micron. The maximum individual fiber loss shall be 3.5 db/km at 850 nm and 1.0 db/km at 1,300 nm. Each fiber shall be color coded. The fiber-optic cable shall consist of 6 fibers. The maximum number of fibers per tube shall be six.

C. Crush resistance shall be 220N/cm minimum.

D. The fiber-optic cable shall have a tensile load rating of 600 pounds minimum.

E. The outer jackets of the cable shall be continuous, free from holes, splits, blisters, or inclusions. The same requirement holds for any inner jackets within a given cable structure as well as fiber coatings.

F. The outer jacket material shall be MDPE. The color of the jacket shall be black in accordance with ASTM D 1248 and contain an antioxidant substance. The carbon black used shall be furnace-type conforming to the designation N 110 in ASTM D 1765. The carbon black content on the jacket material when measured in accordance with ASTM D 1603 shall be 2.6% +0.25% by weight. The light absorption coefficient of the jacket material shall be at least 400 when measured at a wavelength of 375 nm per ASTM D 3349.

G. Outer polyethylene jacket materials shall meet the tensile strength and elongation minimum requirements for unaged and aged samples as follows: tensile strength at break shall be no less than 2,800 psi unaged and 2,100 psi aged. Elongation at rupture shall be no less than 400% unaged and 375% aged.

H. The cable jacket shrinkage test measures the shrinkage or expansion of a cable jacket exposed to temperature aging for a specified period of time. Maximum shrinkage shall be less than 5% for each specimen tested. The test procedure is described in EIA-RS-455, FOTP-86.

I. All of the fiber-optic cable shall be supplied from one manufacturer, exterior cable construction shall be the loose-tube gel-filled type as manufactured by Belden, Siecor, or equal.

J. Fiber-optic cable shall transition from interior to exterior cable in a fiber distribution box within 50 feet from entry into the facility.

K. Tight buffered cable shall not be acceptable for exterior, or underground use.

2.02 FIBER-OPTIC ACCESSORIES

A. Provide fiber optic patch panel connector ST type for each fiber to match fiber optic equipment.

B. Install the connectors after the fiber-optic cables are pulled and run to their desired location.

C. Provide fiber optic cable connectors ST type pre-polished.

D. Fiber optic patch cable and panel shall be manufactured by Siecor, Corning or equal.

E. Provide heavy wall rigid galvanized steel raceways for fiber optic cable.
F. Provide all other raceways, fittings, boxes and terminal cabinets in accordance with specification 16050.

2.03 FIBER OPTIC DISTRIBUTION BOX (FOD)
A. Provide a fiber optic distribution box to enclose indoor/outdoor fiber optic cables connections. Provide, as a minimum, one FOD for each area as indicated on drawings.
B. Locate the FOD enclosure close to RIO enclosure.
C. Meet fiber optic cable recommendation for fiber optic cable connections in FOD enclosures.
D. Provide ST connectors and connect all fiber optic strands to FOD rack.
E. Provide an enclosure with the following characteristics:
      a. Easy to punch, drill, file or saw.
      b. Provide brackets for wall mounting.
      c. Provide hardware grounding kit.
   2. Provide (2) 6-fiber panels for 24 fibers total capacity.
   3. Provide NEMA 4X.
F. Provide FOD Manufacturer by Corning or equal.

2.04 INNERDUCT
A. Innerduct shall be polyethylene plastic duct manufactured from high density, premium grade P34, polyethylene resin in accordance with ASTM standard D-1248. Resin shall be UV stabilized for protection during shipping and outside storage. Color shall be orange.
B. Innerduct shall incorporate internal longitudinal ribs for reducing surface contact and minimizing drag during cable pull.
C. Innerduct shall be provided with pre-installed pull tape.
D. Innerduct shall be ARNCO Starburst Type 11, or equal.

2.05 FIBER-OPTIC SPLICES
A. Fiber-optic splices shall be fusion or mechanical with a 0.2 db maximum loss per splice. Install splices in splice tray organizers specifically designed for the type of splice being used. The splice trays shall be suitable for use with loose tube cables. Splices shall only be allowed by prior written consent of the Owner.

2.06 FIBER-OPTIC SPLICE CLOSURE ASSEMBLY
A. Install fiber-optic splices in pull boxes in a re-enterable splice closure assembly with individually accessible splice trays and an inner and outer closure. Fill the outer closure with an encapsulant to provide a moisture proof seal. Provide AT&T UCB1 with a Type 2000 outer closure, Siecor SC5, or equal.

2.07 CONDUIT SEALANT
A. Seal open ends of buried conduit and conduit entrances into the pull boxes with waterproof putty duct seal LHD-5 by Dottie or equal.

2.08 FIBER-OPTIC PULL BOXES AND HANDHOLES
A. Provide precast concrete pull boxes and handholes for cable installation. The pull boxes shall be traffic bearing and designed for H-20 bridge loading. Covers shall be galvanized steel with Communications bead welded on the upper surface. Knockouts in the wall shall permit underground conduit penetrations. Embed 1-5/8-inch by 2-foot galvanized steel channel inserts on each side of the interior of the pull box for attachment of the cable supports. Refer to Section 16110 for handhole dimensions. Accessories shall include angle iron and pulling eyes. Provide Brooks Type 200FPB, or equal.

2.09 SUPPORTS
A. Support the fiber-optic cable on porcelain saddles attached to 1-5/8-inch structural channel on the inside of the fiber-optic pull boxes. Secure the cable to the porcelain saddles with cable tie wraps.

PART 3 EXECUTION
3.01 CABLE PACKAGING
A. Permanently mark the cable to identify the manufacturer, date manufactured, length of cable, product identification code, and UL messages when appropriate. The marking shall be printed at regular intervals of not more than 1 meter apart.
B. Package the cable and duct on a reel with inner hub diameter greater than the recommended minimum bending diameter of the cable. The anchor holes on the reels shall admit a 63.5-mm (2.5-inch) diameter spindle without binding. The package shall be sturdy enough to endure reasonable handling in the process of shipping and storage.
C. The following information shall be securely attached to the reel (as a tag) or clearly and permanently stenciled or labeled on each reel: customer order number, customer job number, customer reel number, termination, ship date, manufacturer's name, factory reel number, manufacturer's cable code (type and fiber count), length of cable, weight of cable and reel, and defect tag.
D. Seal the ends of all cable and duct to prevent the escape of filling compound and to prevent the entry of moisture during shipping, handling, storage, and installation.

3.02 FIBER-OPTIC CABLE INSTALLATION
A. The installation of the fiber-optic cable and inner duct shall be performed by workers skilled in fiber optic installations. Install the fiber optic cable in ducts as shown on the drawings, with an identification tape installed 12 inches above it.
B. Do not place the cable in tension during installation. Minimum cable bending radius shall be 6 inches.
C. During installation, do not kink the cable and inner duct as it comes off the spool. Do not allow vehicular or pedestrian traffic to run over the duct or cable. Use dynamometers or break-away pulling swings to ensure the pulling line tension does not exceed the installation tension values specified by the manufacturer. The maximum pulling tension for each pull shall be recorded and submitted after the installation is complete.

3.03 SPLICING
A. Do not splice the fiber-optic cable unless authorized in writing by the County.

3.04 CONDUIT INSTALLATION
A. Pull an mandrel through the conduit to check the inside diameter and verify that the conduit is free from obstructions. If the mandrel will not pass through the conduit, replace or repair the conduit at the obstruction point.
3.05 INNERDUCT
A. Innerduct shall be installed in all underground conduits and ductbanks. Ductbank conduits shall be rodded, slugged, and if required, flushed to remove silt and foreign material and to determine the location of collapsed sections.
B. Innerduct may be routed through another ductbank conduit if a collapsed section is encountered. Final determination and selection shall be made by the Engineer.
C. The maximum pulling strength limits of the innerduct during installation shall not be exceeded. Innerduct pull tensions shall be monitored at all times during installation.
D. To reduce friction and minimize pulling forces during installation, a polymer based, water soluble lubricant shall be used when pulling innerduct.
E. Within manholes, innerduct shall be cut to allow sufficient duct protruding from the ductbank conduit for joining corrugated slit duct.

3.06 FIELD TESTS
A. Install connectors on each fiber to perform the field tests. Test fibers for breaks, abnormalities, and overall attenuation characteristics to ensure that the installed cable adheres to the required optical parameters. Provide written certification of the db loss at each splice point and test location.
B. Perform attenuation tests at the following times:
   1. After delivery to the site, before the cable is removed from the reel.
   2. Before a splice is made.
   3. Final test at each end of the cable after all the splices have been made.
C. Remove, replace, and retest any cable section that exceeds the allowable attenuation. After the field test has been successfully completed, remove the connectors at the splice locations and install the splices.
D. The Owner’s Representative will witness the testing and final checkout of the fiber-optic system to determine if the system complies with the contract documents.

3.07 TEST RESULTS
A. Furnish written certification of all tests conducted for each fiber at each splice point and at the end of each fiber-optic cable run. Certification shall clearly label the test type, the test location, test date, wavelength, index of refraction, fiber number, and fiber color. Also provide at each test location:
B. Overall distance and distances to each and every splice location on an individual fiber.
C. Overall attenuation with a comparison to the allowable overall attenuation characteristics specified herein and attenuation of each span of cable between two adjacent splice locations.
D. Individual Splice Loss: Splice loss measurements shall be arrived at by averaging the splice losses at each individual splice from both directions of the splice by use of an OTDR. Each splice measurement shall have written documentation of the OTDR trace.

3.08 TRAINING OF OWNER’S PERSONNEL
A. Provide the Owner’s operating personnel and/or the Owner’s Representative with one day of formal instruction in the maintenance and operations of the fiber-optic system provided under this contract. The training shall cover overall system theory, hardware splicing, connectors, diagnostics, and troubleshooting.
B. Provide the training sessions at the Owner’s facilities and on the equipment furnished under this contract. The education and instruction of operating personnel shall be by a qualified instructor familiar with the requirements for this project. Each training session shall be for eight hours of formal instruction. Session dates shall be directed by the Owner.

END OF SECTION
SECTION 16140
SWITCHES AND RECEPTACLES

PART 1 GENERAL
1.01 DESCRIPTION
A. This section describes materials and installation of light switches and receptacles.

1.02 RELATED WORK SPECIFIED ELSEWHERE
A. General Electrical Requirements: 16010

1.03 SUBMITTALS
A. Submit shop drawings in accordance with the Section SP-09.
B. Submit material list for each type of switch, receptacle, and cover plate. Indicate type, ratings, material, color, and manufacturer.

PART 2 MATERIALS
2.01 GENERAL
A. Provide switches and receptacles that are listed by Underwriter’s Laboratories, Inc.

2.02 RECEPTACLES
A. Provide corrosion-resistant receptacles, unless otherwise noted. Provide gray melamine, duplex receptacle, Hubbell 53CM62GY or equal.
B. Ground Fault Interrupter Duplex Receptacles: Receptacles shall be rated 20 amperes and comply with UL-943, Class A. Provide Leviton 6198-I, 3M GFI-2701, or equal.

2.03 SWITCHES
A. Switches shall be molded composition, brown, specification grade, single pole, three way and four way as shown on the drawings.
B. 120 or 277 Volt Lighting: Provide switches rated 20 amperes, 120/277 volt AC. Provide quiet operation, toggle type switches.

2.04 COVER PLATES
A. Outside, or where indicated, use individually gasketed weatherproof cover plates.
B. Provide satin stainless 302 plates in all remaining locations.

PART 3 EXECUTION
3.01 GROUNDING
A. Provide a bonding jumper between the grounded outlet box and the receptacle ground terminal.

3.02 TESTING
A. Operate each switch and verify that the load is turned on and off.
B. Test each receptacle with a circuit tester that checks voltage, polarity, and grounded conditions. Repair or replace defective receptacles and repeat the test.

END OF SECTION
PART 1 GENERAL

1.01 DESCRIPTION
A. This section includes requirements for materials, testing, and installation of low-voltage motor control equipment.

1.02 RELATED WORK SPECIFIED ELSEWHERE
A. General Electrical Requirements: 16010
B. Variable Frequency Drives: 16157
C. Panelboards: 16160
D. Transformers: 16460
E. Surge Suppression: 16670
F. General Control System Requirements: 16900

1.03 SUBMITTALS
A. Submit Contractor’s Drawings in accordance with Section SP-09.
B. Submit manufacturer’s descriptive data including ratings, circuit diagrams, dimensional data, conduit entry restrictions, and overload relay ratings.
C. Submit Layout and Wiring Diagrams for new and modified motor control centers.
D. Provide Manufacturer’s Equipment Certification and Certificate for motor controls and power monitors in accordance with Section SP-07 and SP-08.
E. Submit dimensional layout drawings and detailed wiring diagrams for installation of all motor controls and power monitors in existing equipment. Contractor is responsible to verify all dimensions and equipment configuration, layout and wiring. Drawings shall include those of modified motor control centers and enclosures with power monitors, including installation of CTs and connection to existing power buses.
F. Submit Operations and Maintenance Manuals in accordance with SP-10.

1.04 RATINGS
A. Motor horsepower ratings and enclosures shown are minimum expected. This does not limit the equipment size. When motors and other equipment furnished differ from the minimum ratings indicated, make the necessary adjustments to wiring, conduit, disconnect devices, motor starters, branch circuit protection, and other affected material or equipment to accommodate the motors actually installed, at no additional cost to the County.

1.05 MANUFACTURER’S SERVICES
A. Comply with Section SP-18.
B. Provide equipment manufacturer’s services at the jobsite for the minimum man-days listed below, travel time excluded:
   1. One man-day installed to check the installation, supervise start up, and supervise testing of the MCC for each process area to be energized.
   2. One man-day to instruct the Owner’s personnel in the operation and maintenance of the equipment, at the site during a time approved by the Owner.
PART 2 MATERIALS

2.01 MOTOR CONTROL CENTERS

A. Motor control centers shall be dead front, dead rear, floor standing, and front accessible NEMA 1 gasketed construction, except for sections with VFD and solid state controllers which shall be NEMA 1 construction. The voltage and ampere rating and physical dimensions shall be as indicated on the drawings. Wiring shall be NEMA Class I, Type B. Tag control wiring from field within 2 inches of termination at each device and terminal board. Schematics shall also show terminal numbers and interior and field wire numbers. Obtain instrument wire numbers from instrument system supplier.

B. Provide channel iron sills and removable lifting angles. Motor control centers shall be constructed of minimum 14 gauge sheet metal.

C. Provide a separate vertical wiring compartment for each motor control center section. Provide cable supports and a hinged door separate from the unit starters.

D. Provide individual compartments separated by steel barriers and with separate hinged doors for each starter, circuit breaker, or other unit. Locate equipment to enable termination of field wiring from front without equipment removal. Motor control center shall have a 12 inch top wireway and a 6 inch bottom wireway.

E. Mechanically interlock starter and circuit breaker doors so doors cannot be opened with unit energized. Provide defeater mechanism to allow intentional access while starter or circuit breaker is energized. Provide provisions for padlocking external disconnect handles in the OFF position.

F. Bus bars shall be tin plated copper and braced to withstand minimum symmetrical short circuit current, as shown on drawings. Provide full horizontal bus rating for entire length of the motor control center. Do not taper the bus.

G. Provide a continuous, frontal accessible 300-ampere-minimum ground bus extended the full length of the motor control center.

H. Feeder circuit breakers shall be molded-case type and lockable in the on and off positions. Provide quick make and quick break toggle mechanism, inverse-time trip characteristics, and trip-free operation on overload or short circuit. Automatic tripping shall be indicated by a handle position between the manual OFF and ON position. Provide trip ratings and number of poles as indicated on the drawings. Provide breakers with fault current interrupting ratings equal to or greater than the motor control center short-circuit current rating. If necessary to comply with this provision, breakers shall be equipped with current-limiting fusing.

I. Main circuit breakers shall be as described above for feeder circuit breakers except without the inverse - time trip characteristics.

J. Combination starters shall be as described in “Combination Magnetic Motor Starters” in this section.

K. Each compartment shall have nameplates made from pneolic material with 1/4” white lettering on a black background, as specified in Section 16010.

L. Motor control centers shall comply with applicable NEMA, UL, and ANSI standards for industrial control.

M. Motor control centers shall be factory finished with ANSI 61 medium gray paint.

N. Provide rubber floor matting in front of each new motor control center section. Rubber matting to meet ASTM Designation: D178-24 for electrical and physical requirements.

O. Motor control center shall be manufactured by Allen Bradley, Siemens, or Square D.
P. Verify that overall equipment dimensions are within the maximum dimensions indicated on the plans. If larger equipment is required, submit a proposed layout showing arrangement of electrical equipment. Provide working clearances in accordance with the NEC. Any costs due to rearrangement of equipment shall be borne by the Contractor with no additional expense to the Owner.

2.02 COMBINATION MAGNETIC MOTOR STARTERS
   A. Comply with NEMA ICS, Class A, and with NEC Article 430.
   B. Combination motor starters shall be thermal trip circuit-breaker type, with ratings as noted on the drawings. If ratings are not shown on the drawings provide circuit breakers and motor starters as required by the NEC and as recommended by the manufacturer for the connected load. The short-circuit rating shall be equal to or greater than the bus bracing rating for the MCC, or a minimum of 42,000 A for enclosed or open-type combination starters. Where indicated short-circuit duty exceeds the starter’s rating, provide current-limiting type breakers or circuit breakers with current limiters of type and rating required to comply with indicated main bus rating.
   C. Provide motor starter overload relays for each motor starter. The overload shall be the same manufacturer as the motor starter and include a manual reset. The manufacturer shall verify the motor ratings and coordinate the overloads with the actual horsepower ratings of the motors installed.
   D. Provide indicator lights, selector switches, push buttons, etc., as shown in the wiring diagrams and single line diagrams. Mount on the front panel of the control panel.
   E. Provide externally operable overload relay reset buttons and disconnect operators.
   F. Provide control relays within the starter enclosure as shown in the schematic wiring diagrams.
   G. Control switches shall be round, heavy duty, oil tight type, 30.5mm complete with legend plates and quantity of contact blocks required for the control function.
   H. Indicating lights shall be round, heavy duty, oil tight type, 30.5mm complete with color of lens indicated on drawings and legend plate. Lamps shall be 120-volt a-c. Indicating lights shall be LED cluster type with a life cycle of over 100,000 hours. Indicating lights shall be push-to-test type.
   I. Elapsed time meters shall be synchronous motor driven, 0 to 99,999.9-hour range, non-reset type, suitable for semi-flush, panel mounting.
   J. Starters and each unit compartment door shall have engraved nameplates made from black on white laminated plastic with 1/4" white lettering on a black background. Refer to Section 16010. Attach nameplates with rivets. Nameplate descriptions shall have full names and approved as part of the shop drawing submittal.
   K. Auxiliary contacts shall be provided as indicated on drawings, include a minimum of one spare normally open and one spare normally closed contact.
   L. Provide terminal blocks in each starter where external controls or indicators are required. A schematic diagram shall be provided inside the cover of each starter. This diagram shall show terminal block identifications for each external connection.
   M. Enclosed combination starters shall be panel mounted in an enclosure designated for the area. All panel devices shall have NEMA rating and type as required by Specification 16010.
   N. Time-delay relays shall be UL listed with contacts rated 10-ampere noninductive load, 120 volts, with coil voltage, number of poles, pole arrangement, and maximum timing adjustment as indicated on the drawings. Relays with maximum timing adjustment 180
seconds or shorter shall be plug-in, solid-state type with timing knob adjustment. Provide Potter Brumfield, Square D Class 9050, Type FS, or equal.

O. Control devices shall be same as those specified in Section 16946.

2.03 MANUAL MOTOR STARTERS

A. Provide number of poles and size of thermal overload heaters for the motor being controlled. Provide NEMA 4x enclosure for starters, unless otherwise indicated.

B. Starters shall have provisions for padlocking in the off position and shall be UL listed.

C. Starters shall be the heavy-duty type with toggle or push button operation. Arrow Hart Type LL, Allen-Bradley Bulletin 609, or equal.

D. In Class 1, Division 1 and Class 1, Division 2 hazardous locations provide manual motor starters in NEMA 7 enclosures.

2.04 SOLID STATE CONTROLLERS

A. The solid-state starter shall be a 6-SCR device fully rated for continuous operation for 40 degrees C ambient. The control section shall be digital microprocessor based.

B. The controller shall comply with the following requirements:
   1. Dielectric withstand per UL-508.

C. Provide the following functions:
   1. Soft start with selectable kickstart.
   2. Current limit.
   3. Full voltage start.

D. The acceleration ramp time shall be selectable from 2 to 30 seconds.

E. The initial torque shall be adjustable from 5% to 90% of locked rotor torque.

F. Kickstart function shall provide an adjustable time pulse of current prior to the normal start mode. The current shall be held at 500% of full load for an adjustable time. This feature shall be field defeatable.

G. Provide the following protection during “starting” and “running” modes. When these conditions are detected, starting of the controller shall be inhibited or the controller shall be shut down if it is operating:
   1. Start fault (faulty SCR firing).
   2. Line fault (phase loss, open motor lead, shorted SCR).
   3. Temperature fault (SCR rated temperature exceeded).
   4. Stalled motor.

H. Provide LED indicators for advisory status and fault annunciation. The LEDs shall be color coded for distinct annunciation and shall consist of:
   1. Control voltage present (green).
   2. Starting (amber).
   3. Running (green).
   4. Stopping (amber).
5. Fault (red).
7. Stalled motor (amber).
8. Line fault (green).

I. The controller shall contain a latch circuit for three-wire control. It shall also be provided with two-wire control circuit.

J. The controller shall have a Form C auxiliary contact for customer use. The contacts shall change state instantaneously on a start command and when the logic completes the ramp-down feature. It shall be possible to reconfigure the system via a switch such that the contacts change state when the controller has determined that the motor is “up-to-speed” and when the motor starts to decelerate.

K. Soft Stop: The deceleration ramp time shall be selectable with settings from 2 to 60 seconds. This feature shall be field defeatable.

L. Motor Control: This function shall reduce surges in a system during starting or stopping of the motor by smoothly accelerating and decelerating the motor. Motor starting shall also be accomplished via soft start, current limit, or full voltage. Starting and stopping time shall be adjustable.

M. Equip the controller with heatsink assemblies.

N. Provide ground provisions for the controller mounting flange.

O. The controller shall incorporate integral fan(s) for forced air ventilation.

P. Provide metal oxide varistors for transient protection.

Q. Equip controller with lugs to accept the wire sizes indicated in the drawings.

R. The controller shall be capable of:
   1. 600% current rating, 10 seconds
   2. 450% current rating, 30 seconds

S. The controller shall operate properly at the temperature, humidity, and altitude of the project.

T. Provide 3-phase motor thermal overload relay.

2.05 SURGE PROTECTION

A. Provide surge protection as shown on the drawings for motor control centers. (Refer to Section 16670.)

2.06 POWER MONITOR (PM)

A. Power Monitor (PM) shall be a panel-mounted, 3-phase microprocessor based monitoring device that provides complete electrical metering, displaying and remote monitoring of electrical parameters as listed herein and as shown on the drawings.

B. The PM shall be UL listed. The PM shall support 3 and 4 wire Wye, 3 wire Delta and single-phase systems as shown on the Drawings and as specified herein. The PM shall accept input from standard 5A secondary instrument transformers.

C. Voltage monitoring range shall be up to 300 VAC phase-to-phase for 120/208 volt system or 300 VAC phase-to-neutral and 600 VAC phase-to-phase for 277/480 volt system.

D. PM shall measure True RMS voltage, phase-to-phase, phase-to-neutral, current per phase and neutral, real power, reactive power, and power factor. PM shall monitor total accumulated energy, total accumulated reactive energy and total apparent energy.
E. PM shall calculate average, max/min demand values for all readings. A time/date stamp must be recorded when a max or min is detected.

F. The accuracy shall be a minimum ±0.2% of full scale for current and voltage readings and ±0.4% for power, energy and ±1.0% for power factor readings. Accuracy shall be maintained from 10 to 115% of nominal for voltage, 3 to 140% of nominal for current and from −0.50 to 1.00 to +0.50 power factor. The resolution for current, voltage and power parameters shall be 0.1% and for power factor 1.0%.

G. The PM display shall have a standard switchboard instrument size footprint with mounting per ANSI C39.1. The PM shall have high intensity L.E.D.s or LCD of at least 5/16-inch height letters. Displayed power measurements shall include Volts, Amps, Watts, VARs, KWH and Power Factor. The totalized power readings shall be displayed in Five-digit resolution minimum. Provide a listing of the register locations in the PM where the collected data is accessible, via the communication port.

H. The power monitors shall have the following characteristics:
   1. Current Input Range (for each channel)……….5A at full scale
   2. Overload withstand……………………………………surge 10X for 3 seconds
   3. Surge withstand……………………………………per IEEE C37.90.1
   4. Frequency Range…………………………………0-75Hz, 60Hz – Nominal
   5. Temperature………………………………………-4°F to 150°F

I. Fused potential transformers shall be incorporated into the Monitoring system. Provide split core window type, current transformers, fuses, disconnects, lugs, wiring, potential taps and accessories with ratios suitable for service voltage and current rating of system being monitored. Current transformers shall be capable of carrying full load continuous primary current without damage to transformer insulation. Voltage and current transducers shall be self-powered, solid state device, AC input, DC output insensitive to load variations from 0 up to 19,000 ohm; with multiturn adjustable potentiometer accessible through a siding access port providing a 0-1 mA DC output. Transducers shall be Scientific Columbus Model VT110A2 (voltage) and CT510A2 (current), or equal.

J. Power monitor shall communicate through Ethernet Communications to the Programmable Logic Controller for gathering data.

K. Power monitor shall be Allen Bradley, Model PM3000 with accessories as noted.

2.07 SPARE PARTS

A. The Contractor shall furnish to the representative of the Owner all necessary spare parts of components required to maintain the system. Prior to final acceptance of work, the system supplier shall provide a spare parts listing of all necessary spare parts and quantities for review of the representative of the Owner. Minimum spare parts to be provided shall include:
   1. Five (5) fuses of each type
   2. Five (5) lamps of each type pilot light
   3. Five (5) current transformers of each type
   4. One (1) circuit breaker of each current rating and type provided
   5. One (1) NEMA size motor starter of each rating and type provided
   6. Three (3) Overload Element of each rating and type provided

PART 3 EXECUTION
3.01 INSTALLATION

A. Motor Control Centers shall be shipped to the site in one continuous section with all bus connections and line side power wiring to the compartments complete, if possible for the installation. In the event the Motor Control Center is to be disassembled, or shipped in sections, for installation in a building or area, a representative from the Motor Control Center manufacturer shall perform the reassembly of the MCC bus and internal power connections. The Contractor shall not perform this work.

B. Secure motor control enclosures rigidly to floors or mounting pads with 316 stainless steel anchor bolts or concrete wedge anchors. Provide new concrete housekeeping pads for all motor control centers, or extend existing pads as required for new motor control centers.

C. Install motor controls at locations as shown on the drawings. The Contractor shall provide and install all terminations, hubs, connectors, and conduit fittings required for connection of new conduit and wiring to the motor controllers and motor control center. Provide wire identification for all wiring.

D. For motor control equipment which is installed in existing cabinets or motor control centers provide new doors, buckets, operating mechanisms, control transformers and other required equipment.

E. Install power monitors in new and existing motor control centers, switchboards, and other enclosures at locations shown on the drawings. Verify locations prior to installation. Connections to existing buses, wiring, and equipment shall be performed using electrical lugs approved for the installation, splicing of wiring is not permitted. Contractor shall provide all lugs and connectors required for power monitor current and voltage connections. Wiring and equipment shall be protected as required by the NEC.

3.02 TESTING

A. Test the operation of each interlock to verify that the interlock performs its function.

B. Set adjustable trip circuit breakers two settings above the setting that causes the breaker to trip during motor starting. Do not adjust the setting above 1,300% of the motor nameplate current rating.

C. Set protective relaying, main and feeder circuit breaker adjustable set points, and time delays in accordance with the manufacturer’s recommended values.

D. Test operation of power monitoring unit and set all parameters for this application. Provide coordination with the system supplier for connection of the equipment to the PCS and PLC hardware. Testing shall include transfer of data between the power monitor and the new programmable logic controller installed in the control room.

E. Infrared testing shall be performed on all Motor Control Centers and Motor Control Devices in accordance with Specification Section 16010.

3.03 TRAINING

A. Provide at least one 8 hour day to instruct the representative of the Owner and Engineer.

B. The training shall include the following:
   1. General electrical operation and maintenance of the MCC and its associated devices such as circuit breaker, starters, power monitor, and accessories.
   2. Power Monitor configuration, operation, and troubleshooting.
SECTION 16157
VARIABLE FREQUENCY DRIVES

PART 1 GENERAL

1.01 DESCRIPTION
A. This section describes materials, testing and installation of variable frequency drives (VFDs). The application will utilize a variable torque VFD rated for the specified horsepower.

1.02 RELATED WORK SPECIFIED ELSEWHERE
A. General Electrical Requirements: 16010
B. Low voltage motor control: 16155
C. General Control System Requirements: 16900

1.03 SUBMITTALS
A. Submit shop drawings in accordance with Section SP-09.
B. Submit manufacturer’s descriptive data including ratings, circuit diagrams, dimensional data, conduit entry restrictions, and heat dissipation to ambient.
C. Layout and Wiring Diagrams.
D. Manufacturer’s Performance Affidavit.
E. Submit dimensional layout drawings and detailed wiring diagrams for installation of variable frequency drives in existing equipment. Contractor is responsible to verify all dimensions and equipment configuration, layout and wiring.
F. Submit Operation and Maintenance Manual in accordance with Section SP-10. Submit shall include, be limited to, the following:
   2. Final VFD parameter setting in an electronic file. The file can be used by the Owner to download the drive configuration at the field. Provide the associated configuration software to be installed in a laptop computer for parameter visualization.
G. Provide Manufacturer’s Equipment Certification and Certificate for motor controls and power monitors in accordance with Section SP-07 and SP-08.

1.04 MANUFACTURER’S SERVICES
A. Provide equipment manufacturer’s services at the jobsite for the minimum man-days listed below, travel time excluded:
   1. One man-day per VFD installed to check the installation, calibrate the drives, supervise start up, and supervise testing of the drives for each process area to be energized.
   2. One man-day to instruct the Owner’s personnel in the operation and maintenance of the equipment, at the site during a time approved by the Owner.

1.05 FACTORY TRAINING
A. The contractor shall provide a factory-training course to a minimum of four County personnel. The training shall include, as a minimum, the following:
3. Overhaul Instructions.
4. Troubleshooting Techniques.
5. Bus Communications.

B. The training shall be performed by a qualified factory representative at a location within a 50-mile radius of the site, and be a minimum of two man-days, for a maximum of six county personnel.

PART 2 MATERIALS

2.01 GENERAL

A. Variable frequency drives shall consist of variable frequency controllers, bypass starters, as indicated, and controls. Each drive shall operate as a simplex unit with no interaction with other drives. Horsepower rating of each drive shall be sufficient to drive the motor as shown on the drawings under the specified operating conditions.

B. Design equipment to operate under the following conditions:
   1. Altitude to 3,300 feet above sea level.
   2. Ambient 10 °C to 40 °C.
   3. Noncondensing relative humidity to 95%.

C. Equipment shall comply with the requirements of ANSI, IEEE, and NEMA. The electrical equipment, design, and construction shall comply with the provisions of the NEC.

D. The complete VFD assembly shall be “Integrally Equipment Rated” in accordance with UL requirements and shall be suitable for connection of a minimum available fault of 42,000 RMS symmetrical amperes. The VFD circuit breaker shall conform to Specification 16155 for feeder circuit breakers.

E. The pump and blower manufacturer shall be responsible for the coordination of the VFD operation with the specific pump and motor requirements.

F. Variable frequency drives shall be manufactured by Allen Bradley Model 750 or Siemens 6SE6440.

G. The VFD shall comply with IEEE 519-1922 for Harmonic Currents and voltage distortion limits for this application. It is the Contractor’s responsibility to provide adequate equipment, including but not limited to input isolation transformers, input line reactors, DC bus reactors and harmonic filters, as required. The maximum Short Circuit Current (ISC) versus maximum Demand Load Current (IL) ratio (ISC/IL) is less than 20 for this facility. The total demand distortion at the point of common coupling (main switchgear) allowed for this application is 5%.

2.02 ENCLOSURES

A. As indicated on the drawings, provide and install a separate enclosure for each variable frequency drives, uon.

B. Verify that overall equipment dimensions are within the maximum dimensions indicated on the plans. If larger equipment is required, submit a proposed room layout showing arrangement of electrical equipment. Provide working clearances in accordance with the NEC. Any costs due to rearrangement of equipment shall be borne by the Contractor with no additional expense to the Owner.

C. Enclosure shall be floor standing, completely front accessible, ventilated NEMA 1 gasketed. Enclosures shall be suitable for mounting against a wall or back-to-back with other equipment.
D. Provide fan cooling for all VFD cabinets. Maximum temperature inside cabinet shall be less than 95°F. All components, and wiring inside the enclosure for the fan cooling shall be provided by the manufacturer. Provide a 480:120 volt transformer to power the fan.

2.03 VARIABLE FREQUENCY CONTROLLERS

A. Controller shall consist of a power conversion bridge and inverter.
B. Controller shall be pulse width modulated (PWM) design.
C. Controller shall be variable voltage/variable frequency (constant volts per hertz).
D. The controller shall include the following features:
   1. 460-volt a-c, 3-phase, 3 wire, 60-Hz input power.
   2. 460 volt a-c, 3-phase, 3-wire, ungrounded output power.
   3. Input fusing, fast acting.
   4. Input power surge protector, for transient protection up to 10 KV and 250 Joules. (Refer to Section 16670.)
   5. 0 to 650 Hz continuous operating range with 0.01 Hz frequency resolution.
   6. Output current limit, 0% to 250% adjustable, minimum. Limits motor inrush current during startup.
   7. Regulation +/-3% of base speed.
   8. Adjustable acceleration and deceleration rates.
   9. Maximum and minimum speed adjustments.
   10. Frequency skip adjustment (3 minimum).
   11. 115-volt a-c control power for run/stop circuits.
   12. Blower cooled with thermal switch cutout and filters for all intake and exhaust openings.

E. The controller shall include protective circuitry that initiates an orderly shutdown of the inverter without component failure. The controller shall shut down and require manual reset for the following fault conditions.
   1. Overload.
   2. Instantaneous overcurrent.
   3. Inverter fault.
   4. Overfrequency.
   5. D-C link overvoltage.
   6. Cabinet overtemperature.

F. The controller shall shut down for the following fault conditions. The controller shall automatically restart upon a cleared fault condition.
   1. Incorrect phase sequence.
   2. Loss of an input phase.
   3. Input undervoltage.

G. Provide a common failure contact for remote indication of fault conditions previously listed.
2.04 CONTROLS

A. The following data shall be accessible via a digital display mounted on the control cabinet door, and interfaced to the variable frequency drive.
   1. Control power on.
   2. Drive run.
   3. Drive fault.
   4. Drive speed indication, 0% to 100% rpm and 0-60 Hz.
   5. Elapsed time meter, six digits, reading in hours and tenths.
   6. Drive output current and voltage.
   7. Manual speed adjustment, 0% to 100% rpm and 0-60 Hz.
   8. Drive, start/stop (local mode).
   9. As indicated on the drawings.

B. The following operation shall be provided:
   1. With system mode in AUTOMATIC, the motor shall automatically vary in speed proportional to an ungrounded 4- to 20-mA input signal from the PLC.
   2. With system mode in HAND, the motor shall vary in speed in response to the manual speed adjustment.

C. Drive shall have automatic restart following a power failure.

D. Provide minimum five digital inputs, two relay output contacts, and one 4-20 mA analog input. The digital input and relay output shall be programmable. The analog input shall increase the VFD output proportional to the signal.

E. The VFD shall be capable of setting a minimum speed for operation. This setting shall be configured by the Contractor during system testing and startup, with a value indicative of the system hydraulics and operation.

F. The VFD shall be configured to ramp to a preset speed when an input is energized in the VFD. The preset speed setting shall be configured by the Contractor during system testing and startup, with a value indicative of the system hydraulics and operation.

G. Provide pilot devices which meet the requirements specified in Section 16155.

2.05 FACTORY TESTING

A. Subject the variable frequency drives to a rated motor load operational test prior to shipment. Provide written certification of completed and approved factory test.

2.06 SPARE PARTS

A. Provide one complete VFD unit, as specified herein, less the enclosure for each model rating and type provided. Deliver to locations as requested by the County.

2.07 SOFTWARE

A. Provide all configuration software and cables for connection of each type of drive to a laptop computer for setting the drive parameters. The software shall operate Windows XP operating system. A manufacturer’s representative shall configure all drive parameters to operate as specified. The software and license will then be provided to the County after project completion.
PART 3 EXECUTION

3.01 INSTALLATION
A. Drives shall be installed in enclosures at locations as shown on the drawings. Mount drive with the recommended clearances per the manufacturer and local codes.
B. Secure drive enclosure to floor, wall or MCC as shown on drawings. Secure with stainless steel hardware. Provide access of digital display on front of drive.

3.02 TESTING
A. Test the operation of each interlock to verify that the interlock performs its function.
B. The variable speed drive system shall be tested to check correct operation of each drive in the manual variable speed mode and automatic variable speed mode.
C. Test the total demand distortion and odd harmonic distortion of the system at the point of common coupling. The Contractor shall provide all equipment required to test the system. A certified test report shall be submitted by the Contractor for review and approval by the Owner. If the maximum harmonic limits, as required by IEEE 519-1992, for this application, are not satisfied the Contractor shall include additional equipment to meet these requirements at no additional cost to the Owner.

END OF SECTION
SECTION 16160
PANEL BOARDS

PART 1 GENERAL

1.01 DESCRIPTION
A. This section describes materials, testing, and installation of panelboards.

1.02 RELATED WORK SPECIFIED ELSEWHERE
A. General Electrical Requirements: 16010
B. Surge Suppression: 16670

1.03 SUBMITTALS
A. Submit Contractor’s Drawings in accordance with Section SP-09.
B. Show ratings and characteristics including voltage ratings, bussing arrangement, continuous current ratings, fault current withstand ratings, neutral bus rating, enclosure type, ratings and arrangement of over-current protective devices, and mounting provisions.
C. Submit outline and dimensional drawings and conduit entry restrictions.
D. Submit Operation and Maintenance Manual in accordance with Section SP-10.

PART 2 MATERIALS

2.01 LOW-VOLTAGE PANEL BOARD
A. Provide dead front, safety-type panelboards with voltage ratings as scheduled. Panelboards shall be circuit breaker type and suitable for a minimum short circuit rating of 25,000 AICS, unless otherwise indicated on the drawings.

2.02 CABINETS
A. Install panelboard in a flush mount cabinet, or in motor control centers, as shown on the drawings with hinged front doors, catches, and locks. Provide holder for the directory on the inside of the door.

2.03 BREAKERS
A. Molded-case breakers.
   1. Provide quick-make and quick-break toggle mechanism, inverse-time trip characteristics, and trip-free operation on overload or short circuit. Automatic tripping shall be indicated by a handle position between the manual OFF and ON position. Provide trip ratings as indicated in the panelboard. Provide lock-on or lock-off devices where indicated on the drawings.
   2. Single-pole breakers shall be full module size; two poles shall not be installed in a single module. Multiple circuit breakers shall be of the common-trip type having a single operating handle.
   3. For existing panelboards provide circuit breakers with same characteristics as is existing, with ratings as shown on the drawings, or as required by NEC.
   4. Circuit breakers minimum interrupting current rating shall be 25,000 AICS. Provide breakers with same interrupting current as panelboard if panelboard rating is greater than 25,000 AICS.

2.04 BREAKER CONNECTIONS
A. Circuit breaker current-carrying connections to the bus shall be bolted type.

2.05 BUS BARS
A. Bus bars shall be copper. Provide a copper ground bus bar installed on the panelboard frame, bonded to the box, and containing at least 10 terminal screws.

2.06 SPACE ONLY
A. Where “space only” is noted on the drawings, provide connectors, mounting brackets, etc., for the future insertion of an overcurrent device of the size indicated.

2.07 DIRECTORIES
A. Provide typed circuit directories on the inside face of the door of each panel. Do not provide handwritten directories.

2.08 NAMEPLATES
A. Provide nameplates as specified in Section 16010. Designate the identifying nomenclature, voltage and phase of the panel as shown on the drawing; for example, “PANEL A, 208Y/120V, 3-phase, 4-wire, 100-ampere bus.”

2.09 SURGE PROTECTION
A. Provide surge protection at panelboards, as indicated on the drawings. Provide all circuit breakers, wiring, and equipment required for surge protection.

2.10 ENCLOSURES
A. For circuit breakers and panelboards in standalone enclosures, provide NEMA 4X in wet locations (unless otherwise noted), NEMA 12 in dry locations (unless otherwise noted), and NEMA 7 in hazardous locations.

PART 3 EXECUTION

3.01 INSTALLATION
A. Mount the panelboard in locations as shown on the drawings.
B. For wall mounting, secure panelboards with stainless steel hardware and 1/4” spacing behind panel.
C. Install circuit breakers in existing panelboards as shown on the drawings.
D. Install surge protection as indicated on the drawings and refer to Section 16670.

3.02 TESTING
A. Operate each circuit breaker and verify that all phases of each load are disconnected.

END OF SECTION
PART 1 GENERAL

1.01 DESCRIPTION
   A. This section describes materials and installation of the main switchgear distribution centers.

1.02 RELATED WORK SPECIFIED ELSEWHERE
   A. General Electrical Requirements: 16010
   B. Automatic Transfer Switch: 16250
   C. Power System Study and Testing: 16011

1.03 SUBMITTALS
   A. Submit shop drawings in accordance with Section SP-09.
   B. Submit ratings and characteristics including voltage ratings, bussing arrangement, continuous current ratings, fault current withstand ratings, enclosure type, ratings and arrangement of all over correct protective devices.
   C. Submit outline and dimensional drawings, conduit entry restrictions.
   D. Submit ground fault protection system field test results.
   E. Submit Operation and Maintenance Manual in accordance with Section SP-10.
   F. Provide Manufacturer’s Equipment Certification and Certificate for motor controls and power monitors in accordance with Section SP-07 and SP-08.

1.04 MANUFACTURERS
   A. Switchgear shall be manufactured by Eaton, Siemens, General Electric, or Square D.

PART 2 MATERIALS

2.01 GENERAL
   A. The equipment to be supplied shall be metal enclosed low-voltage power circuit breaker switchgear with drawout circuit breaker elements. All power circuit breakers and assemblies shall be produced by a single manufacturer and shall be designed, tested and manufactured in accordance with the standards referenced in this specification.

2.02 CODES AND STANDARDS
   A. The switchgear assemblies and power circuit breakers shall comply with the codes and standards as indicated. Copies of certified design tests shall be furnished if requested to confirm compliance.

3. ANSI C37.17 – Trip Devices for AC and General Purpose DC Low-Voltage Power Circuit Breakers.


8. NEMA SG 3 – Low-Voltage Power Circuit Breakers.

9. NEMA SG 5 – Power Switchgear Assemblies.

10. UL 1066 – Low-Voltage AC and DC Power Circuit Breakers Used in Enclosures.

11. UL 1558 – Metal-Enclosed Low-Voltage Power Circuit Breaker Switchgear.

2.03 ASSEMBLY

A. The switchgear assembly shall be in a NEMA 3R outdoor Aisle-less enclosure and be constructed of multiple, metal-enclosed, ventilated sections. The front of each vertical section is to contain compartments with 14 gauge steel side sheets and compartment barriers of 11 gauge steel. A double thickness of 14 gauge steel is to be provided between vertical sections. The side sheets shall be full height and depth to provide a full metal barrier separating the rear cable compartments between sections. End sections shall include provisions for main bus extension and installation of future vertical sections. The design shall incorporate preformed steel channels, angles, and side sheets bolted together and reinforced to form a rigid, self-supporting, compact assembly.

B. Horizontal barriers are to be provided to form individual circuit breakers, automatic transfer switch and metering compartments. Circuit breaker compartments are to be barriered from the bus compartments through a primary disconnect assembly. Each circuit breaker, automatic transfer switch or metering compartment shall be provided with a hinged front door secured with rotary latches requiring no tools to operate.

C. Circuit breaker compartments shall include stationary primary contact disconnects. The primary disconnects shall be copper, silver-plated at connection points and shall be of one piece construction. The upper set of disconnects shall bolt directly to the main bus and, for feeder circuit breakers, the lower set shall extend to the rear cable area and shall be insulated where they pass through the main bus compartment. Primary disconnects shall be sized for the maximum continuous current of the circuit breaker which will be located in the compartment. Interlocks shall be provided which will prevent a circuit breaker element of the incorrect frame size or interrupting rating from being inserted into the compartment. A stationary circuit breaker frame grounding contact shall be provided which shall be visible with the circuit breaker installed in any position.
D. Secondary control contacts, when required, shall be located in the circuit breaker compartment and shall be of the sliding contact, silver-plated copper design. Barriers shall be provided between terminal points. The secondary control contacts shall engage the drawout circuit breaker element in the connected and test positions.

E. Control circuit fuses for electrically operated circuit breakers shall be located on the side of the circuit breaker compartment and shall be contained in a dead-front, pull-out fuse block with a clear cover. Withdrawing the cover from the fuse block shall automatically remove the control circuit fuses and hold them captive. The fuse block cover shall include provisions for being installed in the reverse position in order to maintain the open control circuit for testing or maintenance purposes while continuing to hold the fuses captive.

F. All control wiring within the assembly shall be continuous and shall terminate on each end at a suitable terminal block. Control wiring shall be 14 gauge, stranded, type SIS, and shall be labeled at each end with sleeve type wire markers. Wire markers shall be machine imprinted with the wire name as indicated on the wiring diagrams. Wrap on wire markers will not be accepted. Terminals shall be insulated locking fork or ring tongue type except where connecting to components that do not accept these terminations. Control wiring for external connections shall be terminated in the rear cable area for ease of access. Metal covers shall be provided over terminal blocks located in the power cable termination area.

2.04 BUS

A. Main bus shall be three-phase, 4 wire, 2000 ampere copper silver-plated connection points. Neutral bus rating shall be 100% of the main bus current rating and shall be located centrally in the structure for ease of terminating cables whether entering from above or below. 600 volt clearances shall be maintained in all horizontal and vertical buses such that insulation is not required. The main horizontal bus shall be run in a vertical, edge-to-edge arrangement for high short circuit strength. Access to the rear cable termination area shall be possible without reaching over the main and vertical bus. Bus bracing shall be as shown on the drawings. A 0.25 inch by 2.00 inch copper ground bus will be provided. Barriers shall be provided which isolate the rear cable termination compartment from the adjacent vertical section.

2.05 MAIN DISCONNECT (BREAKER)

A. Main disconnect device shall be as indicated on the drawings. Device shall be capable of being padlocked in the off position. Provide zero-sequence ground fault protection by solid state relays, field adjustable, with continuous time adjustments. Provide reset and test functions by means of pushbuttons and pilot light or mechanical target to indicate that a ground fault has occurred from a fused 120-volt a-c control source within the main disconnect compartment.

B. Provide phase monitoring relay to protect against single-phase voltage and incorrect phase rotation.

2.06 AUTOMATIC TRANSFER SWITCH

A. Refer to Section 16250.
2.07 MANUAL TRANSFER SWITCH

A. Provide an electrically operated, mechanically held, non-automatic double throw power contactor switch with ampere rating and number of poles as indicated in the drawings. Provide manual transfer switch in NEMA type 3R or 4X, 316 stainless steel enclosure. Switch shall be equipped with a microprocessor or electromagnetic panel which controls the operation and displays the status of the transfer switch’s position and available sources. Control shall be established by means of push buttons mounted on the switch enclosure. Manual transfer switch shall have the same withstand current rating as the automatic transfer switch and shall be tested and listed per UL 1008 standards. Mechanisms shall be an open transition type with quick transfer. Provide a backup manual operating handle and provisions for padlocking in the “OFF” position. The switch shall have an interlock to prevent unauthorized opening of the hinged cover when the switch is in the “ON” position and an interlock to prevent closing the switch mechanism with the hinged cover open. Switch shall be lockable in all three positions. Provide nameplates for each position: “Normal”, “Off”, and “Loadbank Test”. Manual transfer switch shall be a Zenith ZTG series as manufactured by GE, or equal.

2.08 CIRCUIT BREAKERS

A. Circuit breakers shall be power type either electrically or manually operated as indicated on the drawings. Minimum interrupting ratings will be equivalent to the bus rating and shall meet or exceed the interrupting ratings as defined by ANSI standards.

B. Circuit breakers are to be 600 volt class with nominal ratings as dictated by the system voltage. Circuit breakers shall be three-pole, single-throw, operated by a stored energy mechanism, with arc quenchers, main and arcing contact structure, a three-phase solid state trip overcurrent trip unit, trip actuator, three single ratio trip sensors, and primary disconnecting devices. In addition, the circuit breaker element shall have connected, test, and disconnected position indicators, spring charged/discharged indicators, and circuit breaker open or closed indicators all of which shall be visible to the operator with the compartment door closed. It shall be possible to rack the circuit breaker element from the disconnect to the connected position with the compartment door closed. Interlocks will be provided that prevent racking a circuit breaker unless the circuit breaker is open and that prevent closing a circuit breaker unless it is in the connected or test position.

C. Trip units shall be interchangeable so that any trip unit can be used with any frame size circuit breaker. The basic trip unit shall be a self powered, micro-processor based device that measures true RMS currents. Long time, short circuit or ground fault trip indication shall be maintained for a minimum of 48 hours without the need for a separate battery or relay. Peak sensing devices will not be accepted. All adjustment setting switches shall be digitally encoded type with gold contacts.

2.09 FINISH

A. During construction, the structural steel parts, panels, and compartments shall be prepared for painting by a five-stage wash system consisting of an alkaline cleaner, fresh water rinse, iron phosphate treatment, fresh water rinse, and non-chromate sealer. After cleaning and stabilization, the steel parts shall be coated with a thermosetting polyester powder applied with electrostatic equipment at a nominal 2 mils dry film thickness and then cured 425 degrees Fahrenheit for 20 minutes. Paint color shall be ANSI 61 light gray. The paint finish shall be a pencil hardness of 2H, a gloss as defined by ANSI D523-78 of 45-55%, a salt spray rating per ASTM B-117-73 of 600 hours, and shall be outdoor rated per UL1332.
2.10 ACCESSORIES

A. The following accessories are to be provided:
   1. Crank for racking circuit breakers.
   2. Lifting yoke for circuit breakers.
   3. Container of touch-up paint.
   4. Portable test set.

2.11 NAMEPLATES

A. Provide nameplates as specified in Section 16010. Provide a nameplate for each circuit breaker or fusible switch and automatic transfer switch to indicate feeder and load served. The main nameplate shall give the switchgear designation in 1/2 inch-high letters. A second line in 1/4-inch-high letters shall indicate the voltage and phases.

2.12 SURGE PROTECTION

A. Provide service entrance surge protection as indicated on the drawings, and as specified in Section 16670.

2.13 SPARE PARTS

A. The Contractor shall furnish to the County all necessary spare parts of components required to maintain the switchgear prior to final acceptance of work. The Contractor shall provide a spare parts listing of all necessary spare parts and quantities for review by the County. As a minimum the Contractor shall provide a minimum of ten (10) of each type of fuses, light bulbs, and contact kits for the switchgear.

B. The Contractor shall deliver to the County all the required spare parts upon conditional acceptance of the work. The spare parts shall not be used as replacement parts during the guarantee or startup period.

PART 3 EXECUTION

3.01 INSTALLATION

A. Secure switchgears rigidly to floors or mounting pads with anchor bolts or Phillips Drill Company concrete anchors. Anchor Bolts or concrete anchors shall be Type 316 stainless steel.

B. Set protective relaying, main and feeder circuit breaker adjustable set points, and time delays in accordance with recommended values from the Protective Device Coordination Study in Section 16011.

C. Verify that overall equipment dimensions are within the maximum dimensions indicated on the plans. If larger equipment is required, submit a proposed layout showing arrangement of electrical equipment. Provide working clearances in accordance with the NEC. Any costs due to rearrangement of equipment shall be borne by the Contractor with no additional expense to the Owner.
3.02 FIELD TESTS

A. Ground Fault Protective Equipment: The ground-fault protection system shall be performance tested after installation in accordance with NEC 230-95C. Submit a written record of the test to the Owner’s Representative. Record current pickup level and time delay settings to which the equipment was finally adjusted. Measure and record relay pickup current and the relay time delay at two values above pickup. Test or correct system operation at 57% rated voltage. If relay pickup current is not within 10% of the manufacturer’s calibration marks or fixed setting or relay timing does not conform with manufacturer’s published time-current characteristic curves, repair or replace equipment and repeat test.

B. Voltage: When the installation is essentially complete and the plant is in operation, check the voltage at the point of termination of the power company supply system to the project. Check voltage amplitude and balance between phases for loaded and unloaded conditions.

C. If the unbalance (as defined by NEMA) exceed 1%, or if the voltage varies throughout the day and from loaded to unloaded conditions more than +/−5% of nominal, make a written request to the power company that the condition be corrected. If corrections are not made, request from a responsible power company official a written statement that the voltage variations and/or unbalance are within their normal standards.

D. Operate each switch, circuit breaker and automatic transfer switch at least three times, demonstrating satisfactory operation each time.

E. Provide coordination with the Power System Study in Section 16011.

F. Infrared testing shall be performed on the switchgear in accordance with Specification 16010.

3.03 TRAINING

A. Provide at least one- 8 hour day to instruct the representative of the Owner and Engineer.

B. The training shall include the following:

C. General electrical operation and maintenance of the Switchgear and and its associated devices such as circuit breaker, ATS, and accessories.

END OF SECTION
SECTION 16200
POWER GENERATION

PART 1 GENERAL

1.01 DESCRIPTION

A. Provide all equipment, labor, materials, and supervision necessary to install and test stand-by diesel engine driven electric generator sets of the latest commercial type and design as specified herein. Installation shall conform to all applicable state and county codes and be satisfactory for locating at the site shown on drawing without undue detriment to the neighborhood by either noise or environmental considerations.

B. Stand-by power systems shall include a generator set rated for continuous stand-by service at the rating and voltage as shown on the drawings, 1800 RPM, and capable of continuous operation between 15% and 100% of rating. The complete operable stand-by system, factory tested, ready for installation, shall be a package of new and current equipment consisting of:
   1. A diesel engine driven electric generator set to provide stand-by power.
   2. An engine-alternator control console resiliently mounted on the generator set, which shall include complete engine start/stop control and monitoring systems.
   3. Mounted accessories and other equipment as specified herein and/or required for satisfactory operation and monitoring.

C. Related work specified elsewhere:
   1. Fuel Tank: 15550
   2. General Electrical Requirements: 16010
   3. Miscellaneous Electrical Devices: 16051
   4. Automatic Transfer Switch: 16250

1.02 RESPONSIBILITY

A. All generator set systems shall be assembled, tested, and shipped by one supplier so there is one source of supply and responsibility.

B. The supplier shall be a factory trained and certified manufacturer’s representative and shall maintain a complete service facility. The service facility shall be capable of making delivery to the generator set site all generator set parts within 48-hours of placing the order. The supplier shall employ a manufacturer trained and certified technician on a full time basis at the service facility capable of making repairs and responding to service calls within 24-hours of notice. Certified proof of this requirement shall be available from the supplier at the time of submission of a quote.

C. The generator sets shall be manufactured by Caterpillar, Onan/Cummins, or MTU Onsite Energy. No other manufacturers will be accepted.

1.03 QUALITY ASSURANCE

A. The engine generator set system, including all accessories described herein, shall meet all standards established by:
   1. Underwriters Laboratories – UL 2200.
5. MIL-STD-705B.
6. Local, state (including COMAR & MDE), and federal requirements for above ground fuel tanks.

1.04 SUBMITTALS

A. Submit shop drawings in accordance with Section SP-09.

B. Shop Drawings

1. The Contractor shall submit for approval a complete shop drawing package illustrating compliance with the specifications contained herein representing the Emergency Stand-By Power System.

2. The Contractor shall submit the manufacturer’s certification that each generator conforms to the quality assurance requirements as delineated in section 1.03 above.

3. The shop drawing package shall include the following:
   a. Engine generator system plan, elevation, and dimensional drawings clearly indicating all aspects of the system including points for each of the interconnections required, the space required for maintenance and overhaul, and any special interfacing requirements.
   b. Engine generator/exciter control cubicle layout and component descriptions.
   c. Fuel consumption rate curve at various loads, ventilation, and combustion CFM requirements.
   d. Exhaust muffler description and dimension, vibration isolator descriptions, exhaust pipe layouts and dimensions.
   e. Schematic ladder and wiring diagrams for the generator system.
   f. Printed literature and brochures describing the system including all sizing requirements and components specified.
   g. The weight of the engine, generator, and complete system.
   h. Battery, FRP/HDPE battery boxes, and battery charger literature and description.
   i. Layout of the main fuel oil tank, float mechanism, piping schematic, and fuel connection information for the engine. Refer to section 15550.
   j. The specified stand-by KW of the generator shall be for continuous electrical service during interruption of the normal utility power source, and this shall be certified to this effect by the manufacturer for the actual unit supplied.
   k. Factory prototype test results performed on a unit of this size and type.
   l. Procedure for lubricating oil sampling and recommended frequency.
   m. System configuration.
   n. Submit Manufacturer’s certification that the proposed fuel system will work properly, as shown on the drawings and return pipe sizes are
adequate; and that the fuel tank elevation is adequate for proper operation.

C. Submit layout drawing showing generator on new concrete pad with dimensions. Contractor shall field verify all dimensions prior to submittal of shop drawings.

D. O & M Manual
1. Submit Operation and Maintenance Manual in accordance with Section SP-10.
2. Operations and Maintenance Manuals shall be furnished for each facility prior to the system being accepted. This manual shall include start up, shut down, and emergency operating instructions, repair, troubleshooting and preventative maintenance procedures, a complete parts manual, dimensional drawings, separate unit wiring diagrams and schematics, and interconnecting wiring requirements, special requirements for operation of the diesel generator between 15 and 100 percent of rating. The O&M manual shall include manuals for each component of the system, including identification of the individual parts used in the system. The O & M Manual shall include the Master Shop Technical Service and Overhaul System Manual Literature Kit for the generator and engine. Provide final O & M Manuals to Anne Arundel County before acceptance test commences. Refer to Special Provision SP-17 for additional requirements.

E. Installation Certificate
1. Comply with Section SP-08
2. A factory technician from the generator manufacturer shall inspect the installed generator system and certify in writing to the installer that it is installed in accordance with the manufacturer’s recommendations before the system is initially started. The technician shall be present for the initial start up at each facility and make recommendations to resolve any defects experienced. A copy of the installation certificate must be submitted to the County before the generator set is conditionally accepted.

F. Software and User Manual
1. Provide one (1) licensed copy of engine diagnostic software to aid troubleshooting, reading parameters and trouble codes, alarm set points, etc. for the engine control system for series engine provided in this contract. Engine diagnostic software shall be custom designed to restrict owner’s use to “Read Only” activities, and to prevent making changes to engine set points and parameters. Certified manufacturer’s technician training for use of the software shall be provided for a minimum of four (4) county diesel technicians for an 8-hour period. This is in addition to training specified elsewhere in this section or other sections of the specifications. Upon satisfactory completion of the training, the County technicians shall receive factory certification. Provide all configuration software and interface cables necessary for connection of the type of generator supplied to a laptop computer. The software shall be licensed to Anne Arundel County DPW, Bureau of Utilities Electrical Coordination.

1.05 WARRANTY
A. The complete generator set, controls, accessories, and assembly shall be warranted as a whole by the manufacturer for one-year from conditional acceptance for parts and labor. Satisfactory warranty documents naming Anne Arundel County, Maryland as the recipient of the warranty and setting forth the period of the warranty shall be provided before acceptance. The warranty shall identify the supplier as a manufacturer’s representative capable of resolving warranty claims. However, the manufacturer shall remain
responsible on its warranty. Further, individual warranties of the component parts will not be considered as satisfactory warranty documents.

1.06 MANUFACTURER’S SERVICES

A. Provide equipment manufacturer’s services at the jobsite for the minimum man-days listed below, travel time excluded:
   1. One man-day installed to check the installation, supervise start up, and supervise testing of the Generator for each process area to be energized.
   2. One man-day to instruct the Owner’s personnel in the operation and maintenance of the equipment, at the site during a time approved by the Owner.

1.07 TRAINING

A. Provide off-site, factory diesel technician level training by the engine manufacturer. Training shall be provided for maintenance, troubleshooting, and repair of the engine including the electronic fuel injection system, generator, and controls inclusive of the microprocessor controller using the manufacturer’s servicing software. The training shall be two (2), 3-day (minimum) sessions for (2) County Diesel Technicians per session at the generator manufacturer’s nearest authorized maintenance, manufacturing facility or the supplier’s facility. Location shall be 50-miles or less from the site, or supply travel and lodging expenses for each county technician if more than 50-miles from the site. Upon satisfactory completion of the course, the county technicians shall receive factory certification.

PART 2 MATERIALS

2.01 ENGINE

A. The engine shall be diesel fueled, 4-cycle, liquid cooled with mounted radiator, blower fan, and coolant pump. Full pressure lubrication shall be supplied by a positive displacement lube oil pump. The engine shall be equipped with replaceable water/fuel separator, and lube and fuel filters (spin on type if available). The engine speed shall be controlled by an asynchronous governor as manufactured by Woodward, Barber-Colman, or equal, to maintain generator frequency through the range from full to no load at 1800 RPM, 60 HZ. The engine shall be remote starting with a two-wire, solenoid shift, electric starter. Install at least one foot of flexible fuel line between the engine and fuel oil tank.

B. Engine protection devices provided shall include shut down for overcrank, overspeed, high coolant temperature, and low oil pressure.

C. A radiator with blower type fan shall be sized to maintain safe operation between 120-125°F ambient temperature. Total airflow restriction from the radiator shall not exceed 0.5” water at both inlet and outlet. The cooling system shall be pretreated by the engine supplier for inhibition of internal corrosion. The radiator shall be equipped with core guard and fan guard. Cooling system shall be protected against freezing to -34°F, with a 50% ethylene glycol antifreeze solution. The antifreeze shall meet GM 1825 specifications. Provide long life TEXACO engine coolant, or equal. Provide spin on coolant filter system, where available.

D. Silencers:
   1. A super critical type exhaust silencer having an attenuation factor of 35-45 decibels with bottom inlet and horizontal outlet shall be provided for the engine generator set. Silencer shall be as manufactured by Kittel, Maxim, or equal, with companion flange connections at inlet and outlet, and taps for drainage. A suitable length of flexible high temperature stainless steel exhaust pipe with
nipple (only for 150 kw or less generators) or flanges welded to both ends shall be furnished for mounting between the engine and silencer. The exhaust system and piping shall be wrapped with a non-asbestos preformed insulation material to reduce heat radiation, and covered with a metal retainer to hold the material in place and provide additional protection.

2. Silencer shall be mounted above the engine generator set so that its weight is not supported by the engine. Exhaust pipe shall be of sufficient size to ensure that measured exhaust back pressure does not exceed the maximum limitations specified by the engine manufacturer. Exhaust piping shall be extended through the wall with all necessary weatherproof accessories. Piping shall be painted with aluminum paint capable of withstanding temperatures of 600° F.

2.02 GENERATOR

A. The generator shall be synchronous type built to NEMA standards, rated for continuous stand-by at ratings indicated on the drawings, 60 Hz, 0.8 PF, 1800 RPM. Class F insulation shall be used on the stator and rotor, and no materials which will support fungus growth shall be used. The generator shall have a resettable protector for exciter/regulator protection against extended low power factor loads. The generator shall be capable of accepting full nameplate load in one step. The generator shall be rated for operating non-linear loads.

B. An exciter/regulator shall be provided to match the characteristics of the generator and engine. Voltage regulation shall be plus or minus 1% from no load to full rated load. Voltage level adjustment shall be minimum of plus or minus 5%. The solid-state regulator module shall be shock mounted and epoxy encapsulated for protection against vibration and atmospheric deterioration. Voltage dip due to motor starting current shall not exceed 20% for any step loading.

C. Main Line Circuit Breaker

1. A generator mounted main line molded case circuit breaker shall be provided as a load circuit interrupting protection device. It shall operate both manually for normal switching functions and automatically during overload and short circuit conditions.

2. The trip unit for each pole shall have elements providing inverse time delay during overload conditions and instantaneous magnetic tripping for short circuit. The circuit breaker shall meet standards established by Underwriters Laboratories, National Electric Manufacturers Association, and the National Electrical Code.

3. Generator exciter field circuit breakers do not meet the above electrical standards and are unacceptable for line protection.
D. The generator shall have minimum size as specified and as indicated on the drawings. The capacity of the generator shall be rated for two raw sewage pumps and the remaining connected loads. The generator shall be designed to operate linear and non-linear loads, such as variable frequency drives.

2.03 AUTOMATIC STARTING SYSTEM

A. Starting Motor: A DC electric starting system with positive engagement shall be furnished. The motor voltage shall be 24-volt DC for generators 400KW and above, and 12VDC for all other generators.

B. Provide automatic engine starting controls within the generator panel to start the engine automatically from a contact in the transfer switch.

1. When the engine starts, the starting control shall automatically disconnect the cranking controls. The cranking disconnect means shall be electrically self regulating to prevent re-cranking for a definite time after source voltage has reduced to a low value. If the engine fails to start, or any safety device operates while the engine is running, the engine shall be stopped immediately and the starting control locked out, requiring manual resetting.

2. Controls shall provide shutdown for low oil pressure, high water temperature, overspeed, and overcrank. Controls shall include a 10-second cranking cycle limited to 3-5 attempts before lockout.

3. The automatic engine starting control shall incorporate industrial control type elements throughout, which must operate at 80% battery voltage. Relays shall be equipped with silver-gold contacts of the wiping type and shall have adequate pressure to insure reliable performance at battery voltage.

C. Provide a lighted factory built, wired, and tested generator set mounted control panel, NEMA 12 type, vibration isolated, dead front, 14-gauge steel panel with hinged front opening doors for providing required access to all components. Provide removable top and side panels for providing required access to cable entry and terminations. The control panel shall be furnished with the following fused AC and DC controls:

1. DC engine controls including the following: run-stop-remote switch, remote-start-stop terminals, oil pressure gauge, charge rate ammeter, and water temperature gauge.

2. Control cabinet front mounted status lamps shall indicate: low engine temperature, high coolant temperature, low oil pressure, overcrank, and overspeed. Manual reset capability shall be provided.

3. AC output control to include: AC volt meter 3-1/2” diameter, meter switch phase selector with off position, a voltage rheostat, a frequency meter 3-1/2” diameter, and hour meter, and a 3-1/2” diameter AC ammeter with phase selector switch.

4. Dry contacts for remote alarms wired to terminal strips.

5. Automatic starting controls.

6. Panel illumination lights and switch.

7. Generator “Running” and “Fail” relay contacts with normally closed contacts for connection to RTU.

D. Battery Charger/Batteries

1. Provide a current limiting, 6-ampere battery charger to automatically recharge batteries. The DC voltage shall have an adjustable “float” setting underload from 2.15 to 2.35-volts per cell and an adjustable “equalize” setting under load from
2.30 to 2.40-volt per cell. It shall include overload protection, silicone diode full wave rectifiers, voltage surge suppressors, DC ammeter and voltmeter, AC overcurrent protection, and 0 to 24-hour equalize timer. The battery charger shall be suitable for 120-volt AC input. The battery charger shall be LaMarche Model A-46, or equal.

2. Provide a set of rack mounted 12-volt lead calcium storage battery(s) of the heavy-duty diesel starting type for the engine generator set. The battery set shall be of sufficient capacity to provide for one and a half minutes of total cranking time without recharging and be sized for the cold cranking amps as recommended by the engine manufacturer. The battery(s) shall be rated no less than 172-ampere hours. Provide number of batteries and all necessary cables and clamps as rewired by the manufacturer.

3. The batteries shall be mounted in fiberglass (FRP) or HDPE, marine type battery boxes. Batteries shall be located adjacent to base frame on the floor, so that batteries are readily accessible for service and/or removal.

2.04 ENGINE GENERATOR SET BASE CONSTRUCTION

A. The engine and generator shall be mounted in perfect alignment on an all welded preformed structural steel I-beam or C channel skid type sub-base which shall provide for attachment of all specified engine and generator accessories.

B. Provide vibration isolators between the engine generator set skid base and concrete slab. The quantity, size, and type of isolators shall be as recommended by the manufacturer. For engine generator sets weighing over 6,000-lbs. including the skid and all accessory equipment, the vibration isolators provided shall be of the spring type with fiberglass pads.

2.05 FUEL SYSTEM

A. The engine generator set shall be provided with complete fuel oil supply system including an external storage and sub-base tanks, auxiliary pump and fittings, fuel pumps, supply and return piping, and all necessary accessories. All work shall be done in accordance with the requirements of NFPA Pamphlets 30, 31, and 110 and all local regulations.

B. All materials shall be compatible for use with No. 2 commercial fuel oil.

C. The tank shall be sized to hold oil for 24-hours of operation at maximum running load of the facility. (All equipment running at maximum capacity.)

D. The fuel tank shall be an above ground fuel tank as specified in Section 15550, that replenishes a 200 gallons sub-base tank by use of a transfer pump and controls.

E. Prior to conditional acceptance, the Contractor shall fill the tank with No. 2 winter mix fuel oil and replace any fuel used in testing.

F. Provide fuel tank assembly and components which shall meet all state, local, and federal requirements for above ground storage tanks relating to fill piping, vent piping, and spill protection. Provide manufacturer’s certification that the generator provided conforms to all requirements.

G. Top of fuel tank to be coated with Rhino or Line-X coating.

H. Provide fuel gauge mounted in location accessible and readable when enclosure doors are open.

2.06 PANELBOARD

A. Provide 480VAC, 3 phase, 100 Amp HP panelboard, Transformer and LP panel board in the generator enclosure to feed the Generator associated equipment such as Jacket
Water Heater, Battery Charger, Lights, fuel pumps, electrical actuator and internal lights. A 100 Amp, 480 VAC, 3 phase feeder will be route to the Generator to power the generator’s HP panelboard.

B. Provide NEMA 12 panelboards.

2.07 PAINTING

A. The complete generator set shall be painted with the manufacturer’s standard prime and finish paint system. Observed nicks, damage, rust, etc. to the paint system of the installed generator set shall be prepared, primed and finish coated in the field prior to conditional acceptance.

2.08 WEATHER RESISTANT ALUMINUM ENCLOSURE

A. The enclosure shall be 14-gauge steel, pretreated, primed and powder coated aluminum to minimize corrosion and color fading. The frame base shall be weather sealed using a foam strip applied where the frame comes in contact with the fuel tank. Installation of enclosure shall be flush with outside edges of sub base fuel tank.

B. The enclosure frame shall be constructed of powder-coated aluminum or stainless steel structural members. Joining of the members that comprise the frame shall be performed by welding (bolt construction is not acceptable).

C. The top and corner edges of the powder-coated aluminum exterior shall be covered with 2” x 2” x 3/8” aluminum angle structural members that cover the pop rivets used to attached the steel panels to the frame. These angle pieces shall be attached using self-sealing, self-threading stainless steel bolts. The bottom exterior perimeter shall be covered with a 3” wide rub rail to cover pop rivet head. It shall be attached in the same manner as the angle pieces.

D. An aluminum rain collar shall be installed to ensure rain tight integrity of the enclosure. The roof of the enclosure shall be cambered to permit water shed.

E. A penetration through the roof for the muffler discharge piping shall be provided.

F. Bolts and nuts shall be 316 stainless steel.

G. The enclosure shall have a minimum of four access doors to permit easy access to the enclosed genset and associated support equipment. These doors shall be mounted in an aluminum frame and be made of the same material as the enclosure sides and roof. Each door shall have stainless steel butt hinges and a standard three-point latch with keyed handle, unless otherwise noted. The hinges, handles or other hardware shall be installed so as to present a neat, tamper resistant appearance. Contractor shall provide standard locks.

H. The enclosure shall have motorized intake and exhaust louvers. These louvers shall be of sufficient size to allow the genset manufacturer’s specified airflow for cooling and combustion air. Location, size, and number of louvers to be determined by enclosure manufacturer and calculations shall be included in shop drawing submittal to demonstrate proper size selection. All louvers shall be made out of aluminum construction riveted into a hinged aluminum frame with a lockable, 3-point stainless steel latching mechanism or screw latches allowing ready access to the radiator and generator ends while forming a rigid, watertight assembly. The openings shall be covered with stainless steel screens to prevent foreign objects from entering the enclosure.

I. Provide motorized louvers motorize to close and spring return to open.

J. Provide aluminum radiator duct adapter between intake damper and radiator.
K. The Contractor is responsible for obtaining the dimensions required of the generators to size the enclosure and locate other items effecting the fabrication and installation of the enclosure.

L. The enclosure shall be capable of attenuating generator noise to 81 dBA at 7 meters.

M. Provide pre-wired AC distribution package.

N. Warrantee: All materials shall be guaranteed against failure of workmanship for 1-year.

O. Enclosure shall be as manufactured by Onan, Model Quiet Site stage 1, Tramont, or approved equal.

PART 3 EXECUTION

3.01 INSTALLATION

A. Secure generator to concrete pad with type 316 stainless steel anchor bolts as recommended by the manufacturer and as shown on the drawings.

B. Connect power and control conductors to generator as shown on the drawings and as identified herein.

C. Install fuel tank, all associated fuel system devices, piping and electrical, in accordance with these specifications, related specifications and the manufacturer's recommendations. Provide Aluminum walk-way kit to allow access to serviceable parts if top of fuel tank is more than 18" high.

3.02 TESTING

A. Generator shall be field tested as a complete system including all wiring, ATS, load bank connection box, and manual transfer switch.

B. Prototype tests performed on a generator set of the same size and type, required by these specifications, shall be submitted and approved with the shop drawings, required above. The test procedures and results shall be certified by an independent testing laboratory. The tests shall be performed in accordance with NFPA 110 and document the following:

1. Maximum power level.
3. Voltage dip.
4. Fuel consumption.
5. Engine generator-cooling airflow.
6. Governor response time.
9. Three (3) phase short circuit test for mechanical and electrical strength.

C. Factory testing of the generator set to be supplied shall be conducted in accordance with procedures certified by an independent testing laboratory and approved by the County Regional Manager responsible for the operation of the specific installation. The manufacturer shall successfully test the generator set to be supplied, for items defined above, and submit the test results for approval before shipping the generator set to the
job site. A two-hour load bank test shall also be performed and the results submitted before shipping the generator set.

D. Acceptance Tests

1. Acceptance testing of each of the installed generator sets shall be conducted by a factory-trained manufacturer’s representative of the diesel generator manufacturer. An authorized representative of Anne Arundel County will witness the acceptance tests. The test procedure followed will be approved by the County and will include data taken during the procedure outlined above, as a minimum.

a. The test results shall be submitted to, and approved by, the County before the equipment is accepted. The Contractor shall furnish all testing equipment, materials, fuel, etc. needed to demonstrate the set is in compliance with the specification. Any deficiencies brought to the attention of the Contractor shall be corrected and, if warranted or requested by the County, the test shall be re-performed prior to acceptance. Final O & M Manuals shall be submitted before the acceptance tests commence.

b. The acceptance test shall be performed during an eight (8) hour field test during which the manufacturer’s representative shall demonstrate that the system performs in complete compliance with the specifications. As a minimum a full capacity load bank test, performed in accordance with NFPA 110 section 5-13.2. The load tests shall use dry type load banks specifically utilized for this purpose. The load bank will be capable of definite and precise incremental loading and shall not be dependent on the generator control instrumentation to read voltage and amperage of each phase. The test instrumentation will serve as a check of the generator set meters. Load bank testing shall be performed for a period of four (4) hours at the full rated load of the generator. Salt-water brine tank load banks are not acceptable for this purpose, and shall not be utilized for this test.

2. Provide one man-day (8 man hours) of a certified manufacturer’s technician to perform testing and startup of generator set.

3.03 SPARE PARTS

A. Provide all spare parts as indicated below which are installed in the generator provided:

1. 1 – Complete Set of Air Filters.
2. 1 – Set of Fuel Filters.
3. 1 – Set of Oil Filters.
4. 1 – Set of Coolant Filters.

END OF SECTION
SECTION 16250
AUTOMATIC TRANSFER BYPASS/ISOLATION SWITCH

PART 1 GENERAL

1.01 DESCRIPTION
A. This section includes material and installation of automatic transfer switches.

1.02 RELATED WORK SPECIFIED ELSEWHERE
A. General Electrical Requirements: 16010
B. Switchgear: 16165
C. Power Generation: 16200
D. Power system study and testing: 16011

1.03 APPLICABLE STANDARDS
A. The combination automatic transfer bypass/isolation switches covered by these specifications shall be designed, tested, and assembled in strict accordance with all applicable standards of ANSI, UL, IEEE and NEMA.

1.04 SUBMITTALS
A. Submit shop drawings in accordance with Section SP-09
B. Manufacturer shall submit shop drawings for review, which shall include the following, as a minimum:
   1. Descriptive literature.
   2. Plan, elevation, side, and front view arrangement drawings, including overall dimension, weights and clearances, as well as mounting or anchoring requirements and conduit entrance locations.
   3. Schematic diagrams.
   4. Wiring diagrams.
   5. Accessory list.
C. Submit Operation and Maintenance Manual in accordance with Section SP-10.
D. Submit Manufacturer’s Equipment Certification and Certificates in accordance with Sections SP-07 and SP-08.

1.05 EQUIPMENT MANUFACTURER AND PROCUREMENT
The purchase of the automatic transfer switch (ATS) equipment and all associated equipment and labor specified herein shall be by the Contractor from the named manufacturer below.

The automatic transfer bypass/isolation switch shall be manufactured by Russelectric.
1.06 MANUFACTURER'S SERVICES

A. Provide manufacturer's services at the jobsite for the minimum man-days listed below, travel time excluded:

1. Two man days to check the installation, supervise start-up, and supervise testing and adjustments of the transfer switches.

B. Equipment Requirements: Refer to Special Provisions for additional responsibilities of the manufacturer/supplier.

C. Provide one 8-hour day of factory operations, maintenance and troubleshooting training at the generator technician level for the automatic transfer switches for at least (4) persons. In addition, provide for a ½ day of Operator level training for plant personnel.

PART 2 PRODUCTS

2.01 CONSTRUCTION

A. General

1. The automatic transfer switch (ATS) and its associated bypass/isolation (BPS) shall be furnished as shown on the drawings. Voltage and continuous current ratings and number of phases shall be as shown.

2. On 3 phase, 4 wire systems, utilizing ground fault protection; a true 4 pole switch shall be supplied with all four poles mounted on a common shaft. The continuous current rating and the closing and withstand rating of the fourth pole shall be identical to the rating of the main poles.

3. The combination automatic transfer bypass/isolation switch shall be mounted in the switchgear as shown on drawings. Provide NEMA 1 ATS and BPS. The enclosure shall be sized to exceed minimum wire bending space required by UL 1008.

Both units shall be bused together with silver plated copper bus to provide a complete pre-tested assembly. Aluminum buses, and/or cable interconnections are not acceptable. Construction shall be such that the contractor needs to install only the power and control connections.

4. Bypass/isolation switches shall provide a safe and convenient means for manually bypassing and isolating the automatic transfer switch, regardless of the condition or position of the ATS, with the ability to be used as an emergency back-up system in the event the transfer switch should fail. In addition, the bypass/isolation switch shall be utilized to facilitate maintenance and repair of the automatic transfer switch.

5. The automatic transfer switch shall be completely isolated from the bypass/isolation switch by means of insulating barriers and separate access doors to positively prevent hazard to operating personnel while servicing the automatic transfer switch.

6. The transfer switch shall be equipped with an internal welded steel pocket, housing an operations and maintenance manual.
7. The combination automatic transfer bypass/isolation switch shall be top and bottom accessible.

8. The main contacts shall be capable of being replaced without removing the main power cables.

9. The main contacts shall be visible for inspection without any major disassembly of the transfer switch.

10. All bolted bus connections shall have Belleville compression type washers.

11. A fully rated neutral bus bar with required AL-CU neutral lugs shall be provided.

12. Control components and wiring shall be front accessible. All control wires shall be multiconductor 18 gauge 600-volt SIS switchboard type point to point harness. All control wire terminations shall be identified with tubular sleeve-type markers.

13. The switch shall be equipped with 90 degrees C rated copper/aluminum solderless mechanical type lugs.

14. The complete combination automatic transfer bypass/isolation switch assembly shall be factory tested to ensure proper operation and compliance with the specification requirements. A copy of the factory test report shall be available upon request.

B. Bypass/Isolation Construction

1. All main contacts and operating linkages of the bypass/isolation section shall be identical to the ATS, except that the operation shall be manual.

2. The bypass/isolation switch shall have the same electrical ratings of ampacity, voltage, short circuit withstand, and temperature rise capability as the associated ATS. The bypass/isolation switch shall be the load-break type. The main contacts of the bypass switch shall be mechanically locked in both the normal bypass and emergency bypass positions without the use of hooks, latches, magnets, or springs and shall be silver-tungsten alloy, protected by arcing contacts with magnetic blowouts on each pole. The switching mechanism shall provide a quick-break, quick-make operation of the contacts.

3. The primary buswork of the drawout automatic transfer switch shall be connected to the stationary bus stabs in the freestanding cubicle by silver plated, segmented, self-aligning, primary disconnect fingers to facilitate proper alignment between the removable drawout when the ATS is withdrawn and shall be available for inspection without disturbing or de-energizing the main bus.

4. The secondary control disconnect contacts mounted on the ATS shall be self-aligning and shall plug into the stationary elements mounted on the freestanding cubicle. Separate, manual, secondary control disconnect plugs are not acceptable.

5. The isolating portion of the bypass/isolation shall allow the automatic transfer switch to be disconnected from all sources of power and control without opening the enclosure door. The transfer switch shall have a true drawout configuration, which does not require disconnection of any electrically, or mechanical device by maintaining personnel. The automatic transfer switch shall be provided with
rollers or casters to allow it to be removed from its enclosure simply by rolling it out. Positive mechanical interlocks shall be provided to insure that the bypass/isolation functions can be accomplished without the danger of a short circuit. Overlapping contact bypass/isolation switches, that are dependent upon the position of the automatic transfer switch for proper operation, are not acceptable.

6. A fourth pole, switched neutral shall be provided if the associated automatic transfer switch is designed as 4-pole. Basic 4-pole, bypass/isolation switch construction shall be identical to the associated automatic transfer switch construction.

7. Necessary controls shall be provided to ensure that the generator run circuit remains closed when the switch is in the bypass-to-emergency position, even though the associated transfer switch is in the normal position or completely removed from the enclosure.

C. Automatic Transfer Switch

1. The transfer switch shall be double throw, actuated by a single electrical operator momentarily energized, and connected to the transfer mechanism by a simple over center type linkage. Total transfer time shall not exceed one half second.

2. The normal and emergency contacts shall be positively interlocked mechanically and electrically to prevent simultaneous closing. Main contacts shall be mechanically locked in both the normal and emergency positions without the use of hooks, latches, magnets, or springs, and shall be silver-tungsten alloy. Separate arcing contacts with magnetic blowouts shall be provided on all transfer switches. Interlocked, molded case circuit breakers or contactors are not acceptable.

3. The transfer switch shall be equipped with a safe external manual operator, designed to prevent injury to operating personnel. The manual operator shall provide the same contact to contact transfer speed as the electrical operator to prevent a flashover from switching the main contacts slowly. The external manual operator shall be safely operated from outside of the transfer switch enclosure while the enclosure door is closed.

D. Automatic Transfer Switch Controls

1. The transfer switch shall be equipped with a microprocessor based control system, to provide all the operational functions of the automatic transfer switch. The controller shall have two asynchronous serial ports. The controller shall have a real time clock with Nicad battery back-up.

2. The controller shall be equipped with self diagnostics which perform periodic checks of the memory I/O and communication circuits, with a watchdog/power fail circuit.

3. The controller shall use industry standard open architecture communication protocol for high speed serial communications via multidrop connection to other controllers and to a master terminal with up to 4000 feet of cable, or further, with the addition of a communication repeater. The serial communication port shall be RS422/485 compatible.
4. The controller shall have password protection required to limit access to qualified and authorized personnel.

5. The controller shall include a 20 character, LCD display, with a keypad, which allows access to the system.

6. The controller shall include three phase over/under voltage, over/under frequency, phase sequence detection and phase differential monitoring on both normal and emergency sources.

7. The controller shall be capable of storing the following records in memory for access either locally or remotely:
   a. Number of hours transfer switch is in the emergency position (total since record reset).
   b. Number of hours emergency power is available (total since record reset).
   c. Total transfer in either direction (total since record reset).
   d. Date, time, and description of the last four source failures.
   e. Date of the last exercise period.
   f. Date of record reset.

E. Sequence of Operation

1. When the voltage on any phase of the normal source drops below 80% or increases to 120%, or frequency drops below 90%, or increase to 110%, or 20% voltage differential between phases occurs, after a programmable time delay period of 0-9999 seconds factory set at 3 seconds to allow for momentary dips, the engine starting contacts shall close to start the generating plant.

2. The transfer switch shall transfer to emergency when the generator has reached specified voltage and frequency on all phases.

3. After restoration of normal power on all phases to a preset value of at least 90% to 110% of rated voltage, and at least 95% to 105% of rated frequency, and voltage differential is below 20%, an adjustable time delay period of 0-9999 seconds (factory set at 300 seconds) shall delay retransfer to allow stabilization of normal power. If the emergency power source should fail during this time delay period, the switch shall automatically return to the normal source.

4. After retransfer to normal, the engine generator shall be allowed to operate at no load for a programmable period of 0-9999 seconds, factory set at 300 seconds.

5. Provide a manual pushbutton to bypass the time delay on retransfer

F. Automatic Transfer Switch Accessories

1. Programmable three phase sensing of the normal source set to pickup at 90% and dropout at 80% of rated voltage and overvoltage to pickup at 120% and dropout at 1105 of rated voltage. Programmable frequency pickup at 95% and dropout at 905 and over frequency to pickup at 110% and dropout at 105% of...
rated frequency. Programmable voltage differential between phases, set at 20%, and phase sequence monitoring.

2. Programmable three phase sensing of the normal source set to pickup at 90% and dropout at 80% of rated voltage and overvoltage to pickup at 120% and dropout out at 110% of rated voltage programmable frequency pickup at 95% and dropout at 90% and over frequency to pickup at 110% and dropout at 105% of rated frequency. Programmable voltage differential between phases set at 20%, and phase sequence monitoring.

3. Time delay for override of momentary normal source power outages (delays generator start signal and transfer switch operation). Programmable 0-9999 seconds. Factory set at 3 seconds, if not otherwise specified.

4. Time delay on retransfer to normal, programmable 0-9999 seconds, factory set at 300 seconds if not otherwise specified, with overrun to provide programmable 0-9999 second time delay, factory set at 300 seconds, unloaded engine operation after retransfer to normal.

5. Time delay on transfer to emergency, programmable 0-9999 seconds, factory set at 3 seconds.

6. A momentary type load test switch shall be included to simulate a normal power failure, keypad initiated.

7. A remote type load test switch shall be included to simulate a normal power failure, remote switch initiated.

8. A time delay bypass on retransfer to normal shall be included. Keypad initiated. Provide a manual pushbutton to bypass the time delay on retransfer.

9. Contact, rated 10 Amps 30 volts DC, to close on failure of normal source to initiate engine starting.

10. Contact, rated 10 Amps 30 volts DC, to open on failure of normal source for customer functions.

11. Light emitting diodes shall be mounted on the microprocessor panel to indicate: switch is in normal position, switch is in emergency position and controller is running.

12. A generator exerciser shall be provided with (10) 7 day events, programmable for any day of the week and (24) calendar events, programmable for any month/day, to automatically exercise the generator programmable in one minute increments. Also include selection of either "no load" (switch will not transfer) or "load" (switch will transfer) exercise period. Keypad initiated.

13. Provision to select either "no commit" or "commit" to transfer operation in the event of a normal power failure shall be included. In the "no commit position," the load will transfer to the emergency position unless normal power returns before the emergency source has reach 90% of it's rated values (switch will remain in normal). In the "commit position" the load will transfer to the emergency position after any normal power failure. Keypad initiated.

14. Two auxiliary contacts rated 10 Amp, 120 volts AC (for switches 100 to 800
amps) 15 amp, 120 volts AC (for switches 1000 to 4000 amps), shall be mounted on the main shaft, one closed on normal, the other closed on emergency. Both contacts will be wired to a terminal strip for ease of customer connections.

15. A three phase digital LCD voltage readout, with 1% accuracy shall display all three separate phase to phase voltages simultaneously, for both the normal and emergency source.

16. A digital LCD frequency readout with 1% accuracy shall display frequency for both normal and emergency source.

17. An LCD readout shall display normal source and emergency source availability.

G. Bypass/Isolation Switch

1. Operation of the bypass/isolation shall be assured, regardless of the position of the automatic transfer switch.

2. Light emitting diodes shall be provided to indicate: bypass position, fully isolated position, and source availability.

3. Positive sequencing of all contacts, with no possible intermediate position, shall be accomplished through the manual operators from a dead front location. Electrical testing during maintenance of the automatic transfer switch shall be possible in the bypass position.

4. Inherent double-throw (break-before-make) operation shall provide positive assurance against accidental short circuitry of the normal and emergency power sources. Arrangements utilizing interlocking of single-throw devices are not acceptable. The operating speed of the contacts shall be independent of the speed at which the handle is moved.

5. The switch shall be fully manually operated and shall not be dependent upon electrical operators, relays, or interlocks for operation.

6. The bypass/isolation switch shall be listed by Underwriters Laboratories, Inc., Standard UL-1008 and meet the identical withstand ratings of its associated transfer switch.

7. The same manufacturer shall supply both the automatic transfer switch and bypass/isolation switch. The manufacturer shall verify that the design has been in continuous production for not less than 10 years, with at least 100 similar installations operating continuously and successfully for that period of time.

8. Bypass/isolation switch must have mechanical separation of normal and emergency to assure against accidental connection of unsynchronized sources. Electrical interlocking will not be considered acceptable.

H. Approval

1. As a condition of approval, the manufacturer of the combination automatic transfer bypass/isolation switches shall verify that their switches are listed by Underwriters Laboratories, Inc., Standard UL-1008 with 3 cycle short circuit closing and withstand as follows:
### RMS Symmetrical Amperes 480 VAC

<table>
<thead>
<tr>
<th>Amperes</th>
<th>Closing and Withstand</th>
<th>Fuse Rating</th>
</tr>
</thead>
<tbody>
<tr>
<td>100-400</td>
<td>42,000</td>
<td>200,000</td>
</tr>
<tr>
<td>600-800</td>
<td>65,000</td>
<td>200,000</td>
</tr>
<tr>
<td>1000-1200</td>
<td>85,000</td>
<td>200,000</td>
</tr>
<tr>
<td>1600-4000</td>
<td>100,000</td>
<td>200,000</td>
</tr>
</tbody>
</table>

2. During the 3 cycle closing and withstand tests, there shall be no contact welding or damage. The 3 cycle tests shall be performed without the use of current limiting fuses. The test shall verify that contact separation has not occurred, and there is contact continuity across all phases. Test procedures shall be in accordance with UL-1008, and Underwriters’ Laboratories, Inc. shall certify testing.

3. When conducting temperature rise tests to UL-1008, the manufacture shall include post-endurance temperature rise tests to verify the ability of the combination transfer bypass/isolation switch to carry full rated current after completing the overload and endurance tests.

The microprocessor controller shall meet the following requirements:

- Storage conditions - 25 degrees C to 85 degrees C
- Operation conditions - 20 degrees C to 70 degrees C ambient
  - i. Humidity 0 to 99% relative humidity, non-condensing
  - ii. Capable of withstanding infinite power interruptions
  - iii. Surge withstand per ANSI/IEEE C-37.90A-1978

4. Manufacturer shall provide copies of test reports upon request.

2.02 POWER MONITORING TRANSMITTER

Refer to Specification 16155.

### PART 3 EXECUTION

3.01 INSTALLATION

A. The Combination transfer Bypass/Isolation Switches shall be installed within the low voltage switchgear as shown in the drawings.

B. Provide access and working space as indicated or as required.
3.02 ADJUSTMENTS

A. Tighten assembled bolted connections with appropriate tools to manufacturer’s torque recommendations prior to first energization.

3.03 TESTING

A. The acceptance test shall be performed by the manufacturer’s representative. The test shall demonstrate complete operation of the switch and complete compliance with the specifications.

B. Infrared testing shall be performed on Switchgear and associated devices in accordance with Specification 16010.

END OF SECTION
SECTION 16450
GROUNDING

PART 1 GENERAL

1.01 DESCRIPTION
A. This section includes materials, testing, and installation of electrical grounding.

1.02 RELATED WORK SPECIFIED ELSEWHERE
A. General Electrical Requirements: 16010

1.03 SUBMITTALS
A. Submit shop drawings in accordance with Section SP-09.
B. Submit material list for all grounding materials and equipment. Indicate size, material, and manufacturer.

PART 2 MATERIALS

2.01 GROUND RODS
A. Ground rods shall be copper-clad steel, 3/4 inch diameter, minimum 10 feet long, with hardened steel points.

2.02 GROUND CLAMPS
A. Ground clamps shall be bronze.

2.03 GROUND RESISTANCE TESTER
A. The ground resistance tester shall be an instrument specifically designed for ground resistance testing.

PART 3 EXECUTION

3.01 GROUND ELECTRODE
A. Install a bare copper ground loop in the concrete footing of all new structures and as shown on the drawings. Bring the loop to the ground at the motors, distribution transformers, ground main service disconnect bus, or motor control centers. Buried or concealed joints or terminations are not permitted. Protect wires with rigid steel conduit where wires stub up through slab at motor control center.
B. Install ground rods 6" below grade at each corner of new structures. Connect to ground loop with exothermic weld.
C. Equipment Grounding
   1. Connect the ground buses of the distribution transformer to the ground bus within the panel with a grounding conductor.
   2. Ground raceways and noncurrent carrying parts of electrical equipment in accordance with NEC Article 250. Use the metallic conduit system for equipment and enclosure grounding. Grounding through the conduit system shall be in excess of any ground conductors shown on the drawings.
   3. Circuits in nonmetallic conduit shall carry one ground conductor for equipment grounding.
D. Install vehicle grounding system per the manufacturer’s instructions at the Methanol Fill Station. Provide and install all wiring and connections required for a complete system.
3.02 TESTING

A. Before making connections to the ground electrode, measure the resistance of the electrode to ground using a ground resistance tester. Perform the test not less than two days after the most recent rainfall, and in the afternoon after any ground condensation (dew) has evaporated. If a resistance of 5 ohms or less is not obtained, provide a ground rod driven 6 inches below grade and connect to ground test well with No. 4 AWG bare copper wire and repeat the test. If the resistance is still above 5 ohms, inform the County. Additional work will be authorized through a change order to obtain a 5 ohm resistance.

END OF SECTION
SECTION 16460
TRANSFORMERS

PART 1 GENERAL

1.01 DESCRIPTION
A. This section includes materials and installation of low-voltage (600V or less) transformers.

1.02 RELATED WORK SPECIFIED ELSEWHERE
A. General Electrical Requirements: 16010
B. Low Voltage Motor Control: 16155
C. Panelboards: 16160

1.03 SUBMITTALS
A. Submit shop drawings in accordance with Section SP-09.
B. Submit ratings and characteristics including voltage, phases, connections, enclosure type and dimensions, and conduit entry restrictions.

PART 2 MATERIALS

2.01 GENERAL
A. KVA size, voltage, and phase of the transformers are indicated on the drawings.
B. Transformers to be UL listed and labeled where listing applies.
C. Transformers shall be rated for continuous operation in a 40°C maximum ambient temperature.

2.02 DRY-TYPE TRANSFORMERS (25 KVA AND BELOW)
A. Construct transformers in accordance with ANSI C89.2, NEMA ST-20, and UL listed under the requirements of Standard 506.
B. Transformers 5 KVA and larger shall have two 5% FCBN taps on the primary side.
C. Transformers rated 250 VA and below shall have 55°C rise, 105°C insulation system. Transformers rated 0.5 KVA through 25 KVA shall have 115°C rise, 180°C insulation system.
D. Encapsulate core and coil in an insulating resin of the class equal to the temperature rise. They shall be embedded in a resin and filler system to attenuate the sound level.
E. Transformer shall be suitable for installation in motor control center.
F. Transformers shall be Sorgel Electric Division Square D Company; “Quiet Quality”- General Electric Company “QB, ML, QMS,” Westinghouse “EP or EPT,” or equal.

2.03 DRY-TYPE TRANSFORMERS (30 KVA AND ABOVE)
A. Construct transformers in accordance with ANSI C89.2, NEMA TR-27, NEMA ST-20, and UL listed under the requirements of Standard 506.
B. Transformers shall have two 2-/2 FCAN and FCBN taps on the primary side.
C. Transformers shall have 150°C rise, 220°C insulation system.
D. Sound levels shall be within the requirements of ANSI C89.1-2.7.2
E. Transformers shall be ventilated type.
F. Transformers shall be Square D Company “Quiet Quality,” General Electric Company “QL,” or equal.

PART 3 EXECUTION

3.01 GENERAL

A. Set taps under load conditions for correct voltages as shown on the drawings.
B. Install transformers such that no metal-to-metal, concrete, plaster, or wood contact exists between the transformer and structural members.
C. Install transformer on equipment pads in locations as indicated on drawings.

3.02 TESTING

A. Transformers shall have insulation resistance tests made on the windings prior to being connected. The measurements shall be from primary and secondary windings to ground and between primary and secondary windings. The minimum value shall be 10 megohms.
B. Demonstrate secondary voltage is within 5% of rated voltage at full and no load conditions.

END OF SECTION
SECTION 16500
LIGHTING

PART 1 GENERAL

1.01 DESCRIPTION
A. This section includes materials and installation of lighting fixtures as indicated in accordance with Contract Documents.

1.02 RELATED WORK SPECIFIED ELSEWHERE
A. General Electrical Requirements: 16010

1.03 SUBMITTALS
A. Submit shop drawings in accordance with the General Provisions SP-09:
   1. Manufacturer’s catalog data including complete catalog number, accessories, mounting brackets, photometric data, and descriptive literature.

PART 2 MATERIALS

2.01 GENERAL
A. Furnish lighting fixtures of the type indicated on the drawings, complete with lamps, sockets, wiring, and mounting hardware.
B. The use of a manufacturer’s name and model or catalog number in the drawings is for the purpose of establishing the standard of quality, photometrics, and general appearance desired only. Products of other manufacturers will be considered in accordance with the General Provisions.

2.02 LAMPS
A. Incandescent:
   Rough service type, 125 volts, of the type and wattage shown on the drawings.
B. Fluorescent:
   1. 59 watt – T8, energy saving, rapid start, 2900 lumen minimum initial output lamps for use with low ambient type electronic ballasts only, or of similar type for smaller fixtures.
C. Mercury Vapor:
   1. Deluxe white and suitable for the burning position as required for the light fixture.
D. High-Pressure Sodium:
   1. Suitable for burning position as required for the light fixture.
E. LED
   1. 150 watts – LED white High Bay fixture, 10,000 lumens
F. Manufacturers:
   1. General Electric, Sylvania, Westinghouse, Dialight or equal.

2.03 BALLASTS
A. Fluorescent:
1. Provide solid-state electronic T12 ballasts compatible with the lamps provided. Provide ballasts with 97% minimum power factor, less than 20% THD, less than 1.7 current crest factor, Class A sound rating, IEEE 587A (ANSI C62.41) transient protection, FCC Part 18C, Class A EMI filtering, and UL listed.

B. High Pressure Sodium:
1. Provide indoor-outdoor type ballasts. Ballasts shall be single lamp, volts and watts as indicated. At any lamp voltage, from nominal through life, lamp wattage shall not exceed 5% for +/-10% line voltage variation. Ballasts shall have a minimum power factor of 90% and be magnetic regulator type.

C. Manufacturers:
1. Advance, General Electric, Jefferson, Universal, or equal.

2.04 FIXTURE TYPES
A. Fixture types are identified on the drawings in the Lighting Schedule. The schedule specifies fixtures which were utilized for the design, substitutions shall have similar lighting specifications, and materials used in fabrication shall be similar to that specified.

2.05 POLES
A. Pole shaft shall consist of 15 foot round extruded 6063-T6 aluminum alloy with finish to match fixture.
B. Design poles, including handholes and luminaries, for a minimum yield safety factor of 1.5 when subjected to a sustained wind velocity of 100 MPH and wind gusts of 130 MPH. In addition, limit the deflection to 5% of pole length under these conditions.
C. Equip with handhole of sufficient size to permit the pulling and splicing of wires and grounding of the pole. Provide a grounding lug accessible through the handhole to accept a ½-inch-diameter copper conductor. Equip handhole with a cover.

2.06 HAZARDOUS AREAS
A. Lighting fixtures and equipment installed in hazardous and classified areas shall be suitable and rated for installation in such areas. Provide fixtures with equivalent characteristics as those noted in the Luminaire schedule on the drawings, except rated for the applicable hazardous location.

PART 3 EXECUTION
3.01 INSTALLATION
A. Install lighting fixtures as close as possible to the locations shown on the drawings, making adjustments only for the purpose of avoiding interferences.
B. Install lighting fixtures plumb and level, with fixture surfaces parallel and perpendicular to walls and other major structures.
C. Aim exterior adjustable lighting fixtures after dark. Notify Engineer at least three days in advance of aiming fixture. After final adjustment, drill and install self-tapping stainless steel screws to lock adjustment brackets into place.
D. Provide mounting and anchoring of fixtures in accordance with the manufacturer’s requirements.
E. Install continuous rows of fixtures straight and true and equip with necessary parts, such as joining straps, couplings, and nipples.
F. Support fluorescent lighting fixtures at two points minimum from structural elements which are capable of carrying the total weight. Mount fixtures rigidly with no rocking action. Where fixtures are mounted in or on a suspended grid-type ceiling, support fixtures at two points in addition to support from the ceiling grid.

G. Emergency lighting units shall be arranged to provide the required illumination automatically in the event of any interruption of normal lighting such as failure of public utility or outside electrical power supply, opening of a circuit breaker or fuse or any manual act(s) including accidental opening of a switch controlling normal lighting facilities. Provide all the required components for a complete operation.

H. Provide pendant stem-mounted fixtures with swivel hangers. Stem shall be one piece without coupling and shall be finished the same color as the canopy and the fixture, unless otherwise noted.

3.02 TESTING
A. Operate each fixture, demonstrating that all lamps and fixtures are fully operational.

END OF SECTION
SECTION 16670
SURGE SUPPRESSION

PART 1 GENERAL

1.01 DESCRIPTION

A. This section describes the materials and installation requirements for transient voltage surge suppressors (TVSS) for the protection of AC electrical circuits from the effects of lightning induced currents, substation switching transients and internally generated transients resulting from inductive and/or capacitive load switching.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. General Electrical Requirements: 16010
B. Grounding: 16450

1.03 REFERENCES

A. The following standards and publications are referenced for use in various sections of this specification.

   1. ANSI/IEEE C62.41, Guide for Surge Voltages in Low Voltage AC Power Circuits. For purposes of this specification, Category C shall assume a maximum voltage amplitude of ten kilovolts and a maximum current amplitude of twenty kiloamperes.


   4. NEMA LS-1--Low Voltage Surge Protective Devices.


1.04 SUBMITTALS

A. Shop Drawings

   1. Provide product data for each suppressor type in accordance with Section SP-09.

   2. The submittals shall include:

       a. Dimensional drawing of each suppressor type indicating the following.

           (1) Line-to-neutral, line-to-ground, and neutral-to-ground suppression paths


   4. UL Standard 1283 Listing, Electromagnetic Interference Filters, documentation

   5. IEEE C62.41-1991 Category C3 (20kV-1.2/50, 10kA-8/20 μs waveform) let through voltage test results.

   6. Spectrum analysis of TVSS based on MIL-STD-220A test procedures between 50 kHz and 200 kHz verifying noise attenuation exceeds 50 dB at 100 kHz.

   7. Independent third party test results verifying single impulse current rating capabilities.
8. Conductor size, rating, and type for connection of surge protection.

B. O & M Manuals

1. O & M manuals shall be provided in accordance with Section SP-10.

1.05 MANUFACTURER'S QUALIFICATIONS

A. All surge suppression devices shall be manufactured by a company normally engaged in the design, development, and manufacture of such devices for the protection of electrical circuits and electronic equipment.

B. The surge suppressor manufacturer shall provide factory repair service for all nonencapsulated assemblies and replacement parts for all encapsulated units.

1.06 WARRANTIES

A. SPD shall have a warranty for a period of five years, incorporating unlimited replacements of suppressor parts if they are destroyed by transients during the warranty period.

B. Should the suppressor fail for any reason, a one-time replacement shall be provided during the warranty period at no cost to the County.

PART 2 MATERIALS

2.01 PANELBOARD AND MOTOR CONTROL CENTER SURGE PROTECTIVE DEVICE (SPD)

A. SPD shall be UL Listed to UL 1449, Standard for Safety, Transient Voltage Surge Suppressors, and UL 1283, Electromagnetic Interference Filters.

B. SPD shall be designed for integral installation in each panelboard. The mounting position of the SPD shall permit a straight and short lead length connection between the SPD and the point of connection to the panelboard.

C. SPD shall provide suppression components between each phase conductor and neutral, between each phase conductor and ground and between the neutral conductor and ground.

D. All encapsulated SPD’s shall utilize an encapsulant that is UL listed and holds a 94-V2 fire retardant rating. No encapsulant compounds that incorporate epoxy shall be allowed.

E. SPD shall meet or exceed the following criteria:

1. Maximum single impulse current rating shall be 80 kA per phase. (40 kA L-N, 40 kA L-G)

2. Pulse life test: Capable of protecting against and surviving 2000 ANSI/IEEE C62.41 Category C3 transients without failure or degradation of UL 1449 suppression voltage ratings by more than 10%.

3. The UL 1449 suppression voltage ratings shall not exceed the following:

<table>
<thead>
<tr>
<th>VOLTAGE</th>
<th>L-G</th>
<th>L-N</th>
<th>N-G</th>
</tr>
</thead>
<tbody>
<tr>
<td>120/208 V</td>
<td>500 V</td>
<td>500 V</td>
<td>500 V</td>
</tr>
<tr>
<td>277/480 V</td>
<td>1000 V</td>
<td>1000 V</td>
<td>1000 V</td>
</tr>
</tbody>
</table>

F. SPD shall be made of solid-state components and operate biodirectionally.
G. SPD shall have a response time no greater than one nanosecond for any of the individual protection modes.

H. SPD shall be designed to withstand a maximum continuous operating voltage (MCOV) of not less than 115% of nominal RMS voltage.

I. Visible indication of proper SPD connection and operation shall be provided. Visual indication shall be by means of solid state status indicator lights on the front of the SPD.

2.02 MANUFACTURERS

A. SPD shall be provided by the same manufacturer. Provide protection manufactured by Current Technology, Innovative Technologies, or equal.

2.03 LOW VOLTAGE SIGNAL PROTECTION

A. Surge suppression for all control cabinets, PLC cabinets, and instrumentation shall be furnished and installed by the system supplier.

B. Suppressor Performance Criteria

1. Maximum single impulse current withstand, conductor to ground or conductor to conductor: 10,000 amperes (8 X 20 us - waveform).

2. Pulse life rating: 3,000 amperes (8 X 20 us - waveform): 2,000 occurrences

3. Suppressors shall have turn-on and turn-off times of less than one nanosecond.

4. Maximum clamping voltage at 10,000 amperes, 8 x 20 us current waveform, shall not exceed the peak of the normal applied signal voltage by 200%.

5. Suppressors shall be a hybrid design with a minimum of three (3) stages utilizing solid-state componentry and shall operate bidirectionally.

6. Suppressors shall be housed in an enclosure that is compatible with the system being protected.

C. Manufacturers

1. The low voltage signal surge protection equipment for devices shall be provided by Innovative Technologies, or equal.

PART 3 EXECUTION

3.01 PANELBOARD/MOTOR CONTROL CENTER INSTALLATION

A. Install SPD at each panelboard and motor control center (MCC), as indicated on the drawings.

B. SPD shall be mounted adjacent to or integral with the panelboard. SPD shall be mounted in the MCC as shown on the drawings.

C. Neutral and ground shall not be bonded together at the panelboard locations.

D. Provide overcurrent protection as required by the NEC for the SPD.

E. Suppressors shall be close-nippled to the device being protected. The mounting position of the suppressor shall permit a straight and short lead length connection between the suppressor and the point of connection.

F. Securely mount surge suppressor to wall, or panel with stainless steel hardware.

G. Conductors for connection of surge suppression shall be as recommended by the manufacturer for this application, and shall be wrapped together the full length of the conductors.
3.02 TESTING

A. Provide factory certified test reports for each model of suppressor supplied, including test methods and equipment.

B. This section includes materials and installation of lighting fixtures as indicated in accordance with Contract Documents.

END OF SECTION
SECTION 16855
HEAT TRACING AND PROCESS PIPING

PART 1 GENERAL

1.01 DESCRIPTION
A. This section includes requirements for materials and installation of thermostat controlled heat tracing for freeze protection of insulated process piping.

1.02 RELATED WORK SPECIFIED ELSEWHERE
A. Process Piping and Equipment Insulation: 15260
B. General Electrical Requirements: 16010

1.03 SUBMITTALS
A. Submit shop drawings in accordance with the Section SP-9.
B. Submit manufacturer’s catalog data, descriptive literature, and installation instructions for heat tracers, heat tracer power connections, splicing and tee kits, thermostat controls, and signal lights to be installed on PVC, CPVC, steel, and ductile-iron pipe, fittings and valves.
C. Submit specific heat loss calculations for each insulated pipe. Calculations will include pipe sizes, materials, and valve types to document the thermal rating (in watts/lineal foot of pipe) required to maintain the pipe temperature as specified.
D. Submit installation test report.

PART 2 MATERIALS

2.01 GENERAL
A. The heat tracers, power connections, thermostat controls, splicing kits, tee kits, and signal lights shall be supplied by a single manufacturer.

2.02 HEAT TRACER
A. The heat tracer shall be Chemelex Auto Trace, Dekoron 2500 series, or equal.
B. Each heat tracer shall be capable of maintaining the temperature of the insulated pipe, pipefitting, or valve upon which it has been mounted at or above 50°F with an ambient temperature of 0°F.
C. The heat tracers shall utilize a service voltage of 120 volt a-c and a circuit breaker size of 20 amperes. Utilize multiple circuits if the length of heat trace exceeds the manufacturer’s recommended maximum loading for a 20 ampere circuit breaker.
D. Each heat tracer shall consist of parallel copper conductors embedded in a semiconductive heating element. The heating element shall be a continuous strip extending between the copper conductors to provide a heating circuit along the entire length of the heat tracer. The heating element shall be covered by an inner insulating jacket. A tinned copper shield shall surround the inner coating and shall in turn be covered by an outer, corrosion resistant fluoro-polymer coating.
E. The heating element in each heat tracer shall automatically decrease its power output as its temperature increases and thereby prevent tracer burnout. Do not use constant wattage heat tracers. The heating element’s self-contained temperature regulating capability shall occur independently at each point along the heating circuit.
F. The heat tracer shall be capable of being field cut to any length without impacting its heat output per lineal foot.
G. The heat tracer shall not attain a temperature sufficient to damage the pipe, pipefitting, or valve material upon which it is mounted.

2.03 ALUMINUM TAPE
A. Aluminum tape over heat tracers installed on plastic pipe shall be Chemelex AT-180, Dekoron 1528-0A018, or equal.

2.04 POWER CONNECTION
A. The power connection for each heat tracer shall be Chemelex Series PMK-JLP, Dekoron 1548-40000, or equal.

2.05 SPLICES
A. Use Chemelex Series PMK-LS splice connection kit, Dekoron 1548-40000, or equal.

2.06 TEES
A. Use Chemelex Series PMK-LT tee connection kit, Dekoron 1548-40000, or equal.

2.07 THERMOSTAT CONTROLS
A. Heating circuits shall be operated by thermostat controls.
B. Ambient temperature sensing thermostats shall be Chemelex Model AMC-1A, Dekoron 1660-15909, or equal.
C. Provide a 40 amperes contactor in a NEMA 4X enclosure for multiple 20 ampere circuits, Chemelex E304, or equal.
D. Line sensing thermostats with the temperature sensing bulb mounted on the pipe surface shall be Chemelex Model AMC-1B, Dekoron 1660-13809, or equal.

2.08 SIGNAL LIGHT
A. Connect a signal light to the end of each heating circuit to indicate whether the heat tracer is on or off.
B. The signal light shall be Chemelex Model PMK-SL with PMK-LP connection kit, Dekoron 1556-41003, or equal.

2.09 PIPING INSULATION
A. Apply insulation per Section 15260 to heat traced pipes.

2.10 WARNING SIGNS
A. Locate “Electric Traced” signs on the outer surface of the piping insulation at 10 foot intervals (each side of pipe) to indicate the presence of electric tracing.

2.11 HAZARDOUS AREAS
A. Heat trace equipment installed in hazardous and classified areas shall be suitable and rated for installation in such areas.

PART 3 EXECUTION
3.01 INSTALLATION
A. Install heat tracing free of nicks and cuts to its outer jacket.
B. Mount heat tracing parallel to pipe flow. Do not spiral heat tracing strips around the pipe.
C. Secure heat tracers to pipe at 1 foot intervals with a glass cloth tape with silicon pressure sensitive adhesive. Secure heat tracers to plastic pipe with aluminum tape.
D. Provide and install heat tracing for all piping identified on drawings.
3.02 TESTING

A. Prior to insulation, operate heat tracing and verify operation by temperature measurement at 5 foot intervals along the length of the pipe being heat traced. Replace all faulty heat trace, repair is not acceptable.

B. After installation of insulation, retest heat trace as indicated above.

END OF SECTION
SECTION 16900
GENERAL CONTROL SYSTEM

PART 1 GENERAL

1.01 DESCRIPTION

A. The Contractor shall furnish all labor, materials, tools, supervision, transportation and installation necessary to perform the related work specified herein to furnish, install, and test the control system.

B. The Integrator System Supplier (ISS) a pre-qualifier Contractor’s subcontractor shall furnish all material, equipment, labor and services except those material and labor specifically noted, required to achieve a fully integrated and operational system as specified herein and in the following sections:

1. Instrumentation: 16920
2. Control System Equipment: 16942
3. Control Panels: 16946

C. The following activities are specifically excluded from the ISS’s scope of work:

1. WTP-PLC and BPS-PLC application program, testing of the PLC logic, start-up and training activities associated with the WTP and BPS PLCs programming.
2. The WTP’s OIT-1 and 2 and the BPS’s OIT software installation and programming. The Operator interface graphic development, database development, report development, start-up and training associated with the WTP’s OITs and the BPS’s OIT.
3. Development of the data blocks for communication between the WTP PLC and the existing remote radios at the wells, existing DCS, existing Broad Creek I PLC. The ISS is responsible to provide and demonstrate communication between the WTP-PLC and other new and existing PLCs, Radio devices and DCS system.
4. The CPE will provide the final system programming of the control strategy logic after successful configuration of the system is demonstrated by the Contractor. The complete PLC system shall be made available to the programming engineer a minimum of four weeks prior to each preliminary test.

1.02 REFERENCES

A. Equipment, materials, and workmanship shall comply with the latest revisions of the following codes and standards; in addition to all local codes and standards.

1. Instrumentation: Instrument Society of America (ISA).
2. Wiring: National Electrical Code (NEC), ISA S5.3 and S5.4.
3. Control Panels and Equipment: NEMA, UL, and ANSI.
4. Institute of Electrical and Electronics Engineers (IEEE).
5. Electronic Industries Association (EIA).

1.03 ENVIRONMENTAL

A. The equipment shall meet or exceed the following environmental conditions:

1. Temperature: 10 to 40 degrees C.
2. Relative Humidity: Maximum wet bulb 28 degrees C.
1.04 SUBMITTALS

A. Qualification submittal:
   1. The Contractor shall submit for approval within 15 (fifteen) calendar days after Contract Award, detailed information of the ISS qualifications. The qualification submittal shall be submitted and approved before any further submittals will be accepted. Failure to meet his minimum requirements shall be grounds for rejection as an acceptable ISS. The qualification submittals shall contains, as a minimum, the following information:
      a. Five (5) references for wastewater projects successfully completed, on time without outstanding claims or litigation, within the last 5 (five) years.
      b. The name, resume and qualification of supervisory personnel, to be directly responsible for the installation, showing at least 5 water/wastewater projects of similar scope and complexity completed successfully.
   2. The contractor’s local place of business shall be located within a 50 miles radius of the jobsite.

B. Submit shop drawings in accordance with Section SP-09.

C. The submittals shall be prepared and organized by the Contractor. Submit drawings and data as a complete package at one time.
   1. Submittals shall be in three-ring hardcover binders and arranged for convenient use including tab sheets, all indexed, and cross-referenced.
   2. Data sheets for each component, together with a technical product brochure or bulletin. The data sheets shall show:
      a. Component name.
      b. Manufacturer’s model number.
      c. Project location.
      d. Input and output characteristics.
      e. Requirements for electric supply.
   3. Submit certified dimensional drawings and catalog cuts for each size and type of component specified herein. Catalog cuts are to be highlighted to define specific materials of construction and features specified herein.
   4. Submit instruction bulletins for each type of component specified herein. The instruction bulletin shall include installation instructions, wiring diagrams, power requirements, maintenance instructions, and any other details of a specialized nature to the instruments furnished.
   5. Group the data sheets together in the submittal by systems, as a separate group for each system. If within a single system, a single component is employed more than once, one data sheet with one brochure or bulletin may cover all identical uses of that component in that system.
   6. Submit component interconnect drawings showing the interconnecting wiring between all new components.
   7. Submit arrangement and construction drawings for consoles, control panels, and for other enclosed assemblies for field installation. These drawings shall include dimensions, identification of all components, terminal block and device layout, preparation and finish data, and nameplates. These drawings also shall include...
enough other details to define the style and overall appearance of the assembly; include a finish treatment sample.

8. Submit wiring diagrams, schematics, and loop drawings for each panel and enclosure provided. Drawings shall include terminal block and wire identification for panel and field connections, including physical layouts in the panel.

9. Submit installation, mounting and anchoring details for all new and relocated components or entry details.

10. Submit detailed bills of material.

D. Operations and Maintenance Manuals:

1. Operations and maintenance manuals shall be prepared and submitted in accordance with the Section SP-10.

E. Submit Manufacturer’s Performance Affidavit for complete plant control system.

1.05 QUALIFICATIONS AND RESPONSIBILITY OF INTEGRATOR SYSTEM SUPPLIER (ISS)

A. The Contractor’s subcontractor (herein called the integrator system supplier) shall furnish and install all proposed hardware and software as specified herein, supply and install all internal and external wiring within the system, perform and supply all engineering, drafting and configuration to deliver a complete and operable system as specified. All systems shall be the unit responsibility of the System Supplier.

B. The ISS shall provide all programming required for system configuration, communication to the I/O, communication to the WTP and BPS OITs, communication between PLCs, including the existing PLC at Broad Creek I; and general system operation.

C. The ISS shall be responsible to development the required programming and configuration to demonstrate communication between the WTP PLC and the following equipment:

1. Existing Remote radios at the Wells.
2. Existing DCS.
3. Existing Broad Creek I PLC.

D. The System Supplier shall be responsible for providing all software, hardware, and equipment necessary for configuration, programming, and testing of the specified control system equipment and instrumentation.

E. The ISS shall provide the final I/O list to the Engineer 60 days after award of contract.

F. The ISS shall be responsible for coordinating and interfacing with existing and new equipment specified under the contract documents which are an integral part of the system. The ISS shall incorporate interfacing in the detailed systems drawings and data sections.

G. The ISS shall schedule the project to accommodate the requirements of the CPE to develop, test, troubleshoot and train the Owner on the WTP-PLC and BPS-PLC and its associated OITs. The schedule shall exclude any legal holidays or days lost due delays caused by the Contractor or the ISS.

H. The Engineer will witness calibration and final checkout of the instrumentation and control system, prior to testing to determine if the system complies with the contract documents.

I. The County Program Engineer (CPE) will provide the PLC control strategy logic for the system. The ISS will provide the testing and verification of all system hardware, instrumentation, communications, and configuration.

J. The Contractor and the ISS shall be responsible for coordination and interfacing with equipment supplies under these contract documents which are integral part of the
system. The Contractor shall provide all interfacing, devices, fitting, connections required for the entire system operation. The ISS shall demonstrate operation of all software and hardware, including verification of I/O, radio communication, and network communication.

1.06 INPUT/OUTPUT (LIST I/O)
A. The I/O list and the drawings shall be used as a basis for fabrication of the control system. The list shown is a minimum quantity of points. The system supplier shall provide all points specified, as shown on the drawings and as required for operation.

1.07 P&IDs
A. The Process and Instrumentation Diagrams (P&IDs) represent the basic process of the instrumentation and control system. The P&IDs are provided as a supplement to the specifications, I/O list and drawings, and shall be used only if information is not shown or specified elsewhere.

1.08 DESIGN
A. The System Supplier shall utilize the I/O list, drawings, and elementaries as the basic criteria for the design of the instrumentation, schematics, preparation of the data sheets, wiring diagrams, piping layouts, assembly drawings, and other requirements set forth in these specifications.

1.09 DELIVERY, HANDLING AND STORAGE
A. Proper and suitable tools, equipment and appliances for safe and convenient handling and placing of materials and equipment shall be used. During loading, unloading and placing, care shall be taken in handling equipment and materials so that no equipment and materials, including County furnished and existing, are damaged.
B. Materials and equipment, which are damaged or affected as a result of improper handling or storage, shall be subject to removal at direction of Engineer and replaced with new materials, at no cost to County.
C. Store and safeguard equipment. Instruments shall not be stored outdoors. Provide dry, secure storage facilities.

1.10 SPECIAL TOOLS AND SPARE PARTS
A. Spare parts recommended by the equipment manufacturer shall be provided.
B. Provide tool kits and test equipment, as recommended by the manufacturer, necessary for assembling, calibrating and maintaining equipment.

1.11 INSTRUMENT FIELD SERVICES
A. Provide the services of the manufacturer’s representative for not less than one 8-hour day on-site for installation inspection, start-up, and testing of each instrument and device.

1.12 TESTING AND FINAL CHECKOUT
A. The County shall witness testing, start-up and final checkout of the system to determine if the system complies with the contract documents.
B. Provide 4 hours of instruction for each type of instrument.

1.13 GUARANTEE
A. See: One-year guarantee, General Provisions.
B. Repair or replace defective components, rectify malfunctions, correct system problems, and correct faulty workmanship, at no additional cost to the County during the guarantee period.
C. System Supplier shall provide new components for the replacement of defective components, the use of the County’s spare parts is prohibited.

1.14 SYSTEM PROGRAMMING AND CONFIGURATION

A. The ISS shall provide all programming required for system configuration; communications to the I/O, communications to the personnel computer, and communications between PLCs; and general system operation. The system shall be made completely operational, less the Plant PLCs, WTP-PLC and BPS-PLC, control strategy logic, by the Contractor.

B. The CPE will provide the final system programming of the control strategy logic after successful configuration of the system is demonstrated by the Contractor. The complete PLC system shall be made available to the programming engineer a minimum of four weeks prior to each preliminary test.

C. The System Supplier shall be responsible for providing all software, hardware, and equipment necessary for configuration, programming, and testing of the specified control system equipment and instrumentation.

1.15 INSTRUMENT TAGGING

A. Attach a stainless steel tag to each instrument and mechanical device, such as transmitters, valves, etc. Permanently mark the stainless steel tag with the instrument tag number. Tag numbers are shown in the Contract Document for instrumentation.

1.16 MATCHING STYLE, APPEARANCE, AND TYPE

A. All display instruments of each type shall represent the same outward appearance, having the same physical size and shape and the same size and style of numbers and pointers.

1.17 MANUFACTURER’S SERVICES

A. The Contractor shall refer to the special provisions for the requirements of the manufacturer services for all equipment provided in Section 16900 and related sections of the Contract Documents. The services indicated in the special provisions shall be in addition to those indicated in the specification sections.

PART 2 PRODUCTS

2.01 GENERAL

A. Electrical components shall operate on 115 volts ac, 60 hertz unless otherwise specified.

B. Provide two-and four-wire transmitter power supplies in local panels as required.

C. Provide fuses or switches for equipment, as recommended by the instrument manufacturer.

D. Contacts for control of motor operated or electrically operated equipment shall be rated minimum 10 amp at 115 volts. Contacts for low level analog signal switching shall be gold bifurcated, cross bar contacts.

E. Process transmitters shall generate 4-20 mA dc analog output signals.

2.02 RELATED PRODUCTS

A. Provide the equipment as specified in the following sections and as shown on the drawings:

1. Instrumentation – Section 16920.

2. Control System Equipment – Section 16942

3. Cabinets, Panels, Consoles and Devices – Section 16946
4. Process Loop Descriptions – Section 16965

PART 3 EXECUTION

3.01 UNIFORMITY OF COMPONENTS
   A. Components which perform the same or similar functions shall, to the greatest degree possible, be of the same or similar type, the same manufacture, the same grade of construction, the same size, and have the same appearance.

3.02 INSTALLATION OF EQUIPMENT AND ACCESSORIES
   A. Install new equipment in accordance with the installation detail drawings as prepared and submitted by the System Supplier and reviewed by the County. Mount equipment so that it is rigidly supported, level and plumb, and in such a manner as to provide accessibility; protect it from damage; isolate it from heat, shock, and vibration; and be free from interference with other equipment, piping, and electrical work. Do not install consoles, cabinets, and panels until construction work adjacent to their location has been completed to the extent that there shall be no damage to the equipment.

   B. Locate devices, including accessories, where they shall be accessible.

   C. Mount equipment in cabinets or existing panels as specified. Mount associated terminals on a common panel or rack; mounting panels and racks shall have a baked enamel coating.

   D. Coordinate the installation of the electrical service to the specified components related to the system to assure a compatible and functionally correct system. All accessories shall be coordinated and a compatible installation shall be the responsibility of the Contractor.

3.03 CALIBRATION
   A. Calibrate and configure the programmable control and instrumentation system after installation in conformance with the component manufacturer’s instructions. This shall provide that those components having adjustable features are set carefully for the specific conditions and applications of this installation and that the components and/or systems are within the specified limits of accuracy. Defective elements which cannot achieve proper calibration or accuracy, either individually or within a system, shall be replaced. This calibration work shall be accomplished by a technical field representative of the equipment supplier. Certify in writing to the Engineer that all calibrations have been made and that all systems are ready to operate.

   B. Provide 5 point field verification for each instrument. If 5 point verification cannot be performed, such as for flow instruments, provide witnessed field configuration. All instrumentation calibrations shall be recorded and documented on calibration sheets which are to be included in the O&M manual.

   C. Provide a final calibration label on each instrument which includes the tag number, date of calibration/verification, range, and name of person performing calibration/verification.

3.04 PERFORMANCE TESTING
   A. General

      1. Tests will require scheduling among all parties involved so that the tests may proceed without delays or disruptions by uncompleted work. Coordinate operational tests dependent upon completion and sequencing of work specified elsewhere. The County shall approve all test dates.

      2. The System Supplier shall provide onsite assistance to the programming engineer, with a qualified representative of the PLC control system, for a minimum of thirty (30), 8 hour, working days prior to and during testing. The
days will be performed at the request of the County and may not be consecutive. This assistance is in addition to all test requirements specified herein.

3. For each test the system supplier shall submit for approval a test protocol a minimum of 14 days prior to the test. The protocol shall include a list of each I/O point, instrument, device, and control panel in a tabular format. Contract drawings and shop drawings are not acceptable.

4. The County or County’s representative will witness all testing. The System Supplier shall be responsible for all performance testing.

B. Factory Testing

1. Operational tests shall be performed prior to shipping the control system to the jobsite to demonstrate that the hardware, I/O points, and alarms will perform each operation required for all specified conditions and in accordance with Specification 16965, the P&IDs, and the I/O List. The Engineer and a representative for the County shall witness the tests. After the testing is completed, provide a certification and log of all tests to the County for review and comment. The panel wiring shall be checked against the submittal drawings.

2. The factory witness test shall take as long as necessary to demonstrate to the County and the Engineer that the hardware performs each operation as required per the specifications.

3. Prior to factory system testing, submit a written detailed test procedure for review by the County. Notify the County in writing four weeks in advance of the scheduled testing.

C. Preliminary Inspection/Test

1. After installation of the complete specified system, the Contractor shall perform a preliminary inspection test. All equipment shall be operable and interfaced to the existing system.

2. The System Supplier shall perform a complete I/O point test to demonstrate the specified data is transmitted from the field device to the PLC I/O registers and from the PLC I/O registers to the field devices. A certified test identifying all I/O points individually tested shall be provided by the System Supplier, for approval by the County. The System Supplier shall load and utilize their own PLC programming software to perform the testing.

3. The preliminary test will be separated into dependent tests each time a system is put into operation. The System Supplier shall verify all control system operations required for each device prior to establishing system operation.

4. The System Supplier shall demonstrate communications and data transfer between the PLCs, PCs, and OITs. Data shall be show in the software at each OIT from the respective PLC, and at the PC from all PLCs. The System Supplier shall load and utilize their own PLC programming software, and OIT development software for the test.

5. Prior to beginning the pre-final and final testing, the System Supplier must successfully complete, and the County provide acceptance of, the preliminary tests.

D. Pre-Final Inspection/Test

1. All systems shall be retested as specified in the preliminary/inspection test.

2. The System Supplier shall perform the pre-final test in order to demonstrate achievement of the specified performance. The pre-final test will demonstrate
communications to all PLCs from the field location and the operability of each instrument.

3. When systems are assessed to have been successfully carried through the pre-final test and the County concurs in this assessment, a date for final testing involving the County operations personnel and programming engineer will be agreed upon.

E. Final Inspection/Testing

1. The System Supplier shall recheck the system at this time to verify proper operation, and final adjustments shall be made.

2. Upon 100% successful completion of the preliminary and pre-final testing, and approval of the test results by the County, the programming engineer will load the control logic software in the PLCs, the OIT configuration software, and the man machine interface software on the PC.

3. The programming engineer will debug his software for a total time of 14 working days, with the assistance of the Contractor verifying the hardware, prior to the start of the final test.

4. After the programming software is debugged, the final testing period shall consist of fourteen consecutive days of continuous testing. The System Supplier shall be on call 24 hours a day ready to respond and repair the system within two (2) hours during this time. The system shall be 100% operational for the final test period. If the system fails to be 100% operational, the System Supplier shall remedy the problem immediately. The final test will then restart and consist of fourteen consecutive days of continuous testing from the time of failure. The final test period will occur for each system brought into operation.

3.05 TRAINING

A. General

1. Provide the County operating and maintenance personnel and/or the County Representative with a minimum of five (5) days of formal instruction in the functions and operations of the communications, PLC systems, OITs, PCs, instrumentation, and other control related equipment, provided under this contract. The training shall cover overall system theory, hardware architecture, bus communications, maintenance and diagnostics. The education and instruction of operating personnel shall be by a qualified instructor familiar with the requirements for this project. Each daily training session shall be for eight hours of formal instruction. Session dates and locations shall be directed by the County.

B. Manuals

1. The System Supplier shall provide six copies of training manuals for each course.

2. The training manuals shall include, but not be limited to:
   a. Description of operation of each component of the system.
   b. Normal operational procedures.
   c. Abnormal (emergency) operational procedures.
   d. Communications and configuration techniques.
   e. System maintenance.
f. Calibration – including a demonstration for each instrument, device, and component.

3. Operations and maintenance manuals may be used to supplement training manuals.

C. Training Syllabus

1. A training syllabus shall be submitted by the Contractor a minimum of four (4) weeks prior to training for approval by the County. The syllabus shall outline all training criteria and include the instructor’s name and qualifications.

D. Factory Training

1. In addition to the training identified above, a factory training course for CompactLogix PLC shall be provided for a minimum of six (6) County personnel. The training class shall be a minimum of 4 days and be held at a facility less than 50 miles from the site. The training shall be Rockwell Automation RSLogix 5000 Level 3 Project Development Class #CCP143 or Equal training provided by Siemens.
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<th>Proposed Eq ID</th>
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### TABLE 16900-2. Equipment Identification List - Water Treatment Plant

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## TABLE 16900-2: Equipment Identification List - Wells

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Project No: W804000  
Project Name: Broad Creek II Water Treatment Plant  
16900-15  
12/17/2010
SECTION 16920
INSTRUMENTATION

PART 1 GENERAL

1.01 DESCRIPTION
A. This section includes requirements for supplying and testing calibrated field-mounted analyzers, in line flow devices, pressure indicating devices and associated equipment to be provided by the system supplier under Section 16900. A list of instrumentation specified for this project can be found at the end of this section.

1.02 RELATED WORK SPECIFIED ELSEWHERE
A. General Electrical: 16010
B. General Control System Requirements: 16900

1.03 SUBMITTALS
A. Submit shop drawings in accordance with Section 16900.
B. Submit certified dimensional drawings and catalog cuts for each size and type of instrument specified herein. Catalog cuts are to be highlighted to define specific materials of construction and features specified herein. Show tag number of each applicable instrument.
C. Submit instruction bulletins for each type of instrument specified herein. Show tag number for each applicable instrument. The instruction bulletin shall include installation instructions, wiring diagrams, power requirements, maintenance instructions, and any other details of a specialized nature to the instruments furnished.
D. Submit Manufacturer’s Equipment Certification for:
   1. Ultrasonic Level Transmitter
   2. Level Transducer
   3. Magnetic Flow Meter
   4. pH/Cl₂ Free Residual Analyzer
   5. Rotameter

PART 2 MATERIALS

2.01 INSTRUMENTATION PROVIDED UNDER THIS SECTION INCLUDES:
A. Ultrasonic Level Transmitter – 2.2
B. Level Transducer – 2.3
C. Magnetic Flow Meter – 2.4
D. pH / Cl₂ Free Residual Analyzer – 2.5
E. Pressure Switch – 2.6
F. Float level switch – 2.7
G. Rotameters – 2.8
H. Limit switch – 2.9
I. Display Meter – 2.10
2.02 ULTRASONIC LEVEL SENSOR AND TRANSMITTER
A. Provide non-contact measurement consisting of a transducer and transmitter/control unit.
B. Provide an echo-time measuring type transmitter that utilizes an ultrasonic beam to detect the liquid level.
C. Provide a transducer with the following characteristics:
   1. Submersion proof transducer constructed of PVC or CPVS.
   2. Suitable for mounting via flanged tank connection as indicated on drawings.
   3. Automatic temperature compensation for changes in the speed of sound over an ambient temperature range of –20 to 120 degrees F.
   4. Provide adequate transducer cable for the installation shown on the drawings.
D. Provide transmitter with the following characteristics:
   1. 2-wires device
   2. Microprocessor based with adjustable span and zero.
   3. Match transducer range and frequency to the application.
   5. Digital display in engineering units for level.
   6. Thermostat and enclosure heater for outdoor mounted transmitters.
   7. 4 – 20 mA DC Signal output.
   8. Accuracy of 1.0 percent of span.
   9. Ambient Temperature: -40C to 80C
E. Provide corrosion resistant mounting brackets for mounting transmitter. Provide protective cover for transmitter.
F. Manufacturer:
   1. Endress and Hauser, Model Prosonic FMU40.
   2. Or equal.

2.03 HYDROSTATIC LEVEL TRANSDUCER
A. A single pressure transducer shall be submerged in the well or tank to sense the water level as indicated on drawings. The pressure transducer shall have a 4-20mA output and ceramic measuring diaphragm for water applications, which is proportional to the level. The output shall be calibrated based on the length of the cable needed and the depth of the tank or well to be monitored. The transducer signal shall be wired to the programmable controller as indicated on drawings. Provide adequate cable for installation. Contractor shall verify all cable lengths prior to installation.
B. The transducer shall meet the following requirements:
C. Accuracy: 0.2% of full scale
D. Voltage: 0 to 30 VDC
E. Integrated over-voltage and surge protection
F. Process Temperature 14 to 158 F
G. Extension cable: As required
H. Process connection: As shown on drawings
I. Weight
   
J. Provide a NSF-61 potable water approved Level transducer.

K. Provide mounting brackets, junction box and accessories as required for installation.

L. The transducer shall be installed in a Schedule 80 PVC stilling well, satisfactory for water submersion, percolated with 1/4” holes spaced around the tube throughout the entire length of the tube. The bottom of the tube shall be open with the exception of a stainless steel pin suitable to prevent the transducer from falling through. The transducer assembly shall be readily accessible and shall be located in a manner that allows the transducer and cable to be easily removed without entering the well. The transducer and tube assembly shall be mounted and in a manner as indicated on drawings.

M. Provide Endress & Hauser Model Water Pilot FMX21, or equal.

2.04 MAGNETIC FLOW METER

   A. Provide low frequency and short form characterized coil design.

   B. Provide a steel metering tube with flanged body to fit between ANSI Class 150 pipe flanges, unless otherwise specified.

   C. The laying length of the flow meter shall be ISO standard.

   D. Provide flow meters with polyurethane or SBR hard rubber liners and Type 316 stainless steel electrodes.

   E. Provide Liners and electrodes suitable for municipal potable water.

   F. Provide all required mounting hardware, stainless steel grounding rings, and grounding straps for the installation of each magnetic flow meter. Ground the flow meter as recommended by the manufacturer.

   G. Provide coils inside the pipe wall, encapsulated in epoxy resin and encased behind the meter lining material.

   H. The ratio of the flow velocity to reference voltage signals generated shall be compatible with the readout instrument without the necessity of circuit modifications.

   I. Provide the meter with an accuracy of ½ percent of rate for flow rate between 10 percent and 100 percent of the range setting.

   J. Provide a meter housing which is splash proof and weather resistant and capable of accidental submergence in up to 30 feet of water for up to 48 hours without damage to the electronics.

   K. Each meter shall be hydraulically calibrated at a calibration facility located in the United States against a master meter, which is traceable to the National Institute of Science and Technology. Submit the calibration curves for each flow meter for three points within the specified flow range.

   L. Complete zero stability shall be an inherent characteristic of the meter system. This eliminates the requirement for valving downstream of the meter for creating a full pipe zero flow condition for calibration purposes. Meter systems requiring field zero adjustment are not acceptable.

   M. Provide each flow meter with a remote mounted NEMA 4X microprocessor based signal converter with a flow indicator scaled in engineering units. The signal converter converts the meter’s DC pulsed signal to linear 4-20 mA DC signal which is proportional to the flow rate. The flow converter operates on 120 volt AC, 60 Hz power source and has RFI protection.

   N. Provide interconnecting cable of sufficient length to connect each signal converter to its respective flow meter.
O. Each signal converter shall include both a magnetic driver to power the magnet coils and signal converter electronics. Signal converters shall be identical and interchangeable for all meter sizes.

P. The signal converter electronics shall be of the solid state, feedback type, and utilize integrated circuitry, microprocessor controlled. All operational parameters shall be user configurable locally via an integral keypad. All changes to the database shall be by entry of numerical values or selectable from a menu. When in the configuration mode, normal meter output shall be maintained.

Q. Provide the converter with a back lighted, dot matrix-type, liquid crystal display for easy reading of flow and configuration data. Provide the display with two rows of 16 alphanumeric characters as a minimum. For operation, the top row indicates instantaneous flow rate in direct engineering units and the second row displays accumulated total flow. Error messages will announce incorrect entry values, which the converter will reject. Converter failure shall be announced in the display as an error message. An error message will display when the converter fails.

R. Provide an alarm contact for external indication of failure. The range setting of the signal converter shall be continuously adjustable between 5 percent and 100 percent of meter capacity. The range and other parameter adjustments shall be direct reading via the integral digital display. The converter shall have input impedance of 10-12 ohms or greater and not be affected by quadrature noise. The meter shall require no zero adjustment or special tools for startup.

S. Provide fully isolated Input and output signals. The unit shall be capable of accommodating either unidirectional or bi-directional flow. The converter shall incorporate an integral zero return circuit to provide a constant zero output signal in response to an external dry contact closure.

T. The signal converter software includes a noise reduction algorithm to minimize the effects of noise generating processes. The signal converter shall have a self-test feature for checking operational modes and alarms. Continuous diagnostics shall also be performed including, but not limited to, the monitoring of electrode reference voltage to sense meter coil failure. Sensing of meter failure activates a user configurable minimum or maximum output signal and a failure alarm contact.

U. Manufacturer:
   1. Endress & Hauser Model Promag 53 W.
   2. Rosemount Series 8750.
   3. Or equal.

2.05 pH/Cl2 ANALYZER

A. Provide combination pH/Chlorine Residual analyzer. The analyzer shall be designed to analyze water for free or total chlorine residual. The instrument shall consist of a microprocessor based analyzer with 2-electrodes, chlorine and pH.

B. The analyzer shall be designed for use in potable water application and shall be constructed of material resistant to the corrosive action of chlorine and dampness.

C. The analyzer shall meet the following requirements:
   1. Automatic temperature compensation and automatic or manual pH compensation.
   2. Monochromatic graphic liquid crystal display 128x96 pixels display resolution. backlit.
3. Dual Sensor input and output. The two 4-20 mA output signals can be independent programmed to correspond to any selected measurement or temperature.

4. Power supply: 120 VAC, 1 phase, 60 Hz

5. Four fully programmable alarm relays. Form C SPDT.

6. Enclosure: NEMA 4X

7. Provide mounting bracket for installation as shown on drawings.

8. Probes:
   a. pH probe with the following characteristics:
      - Insertion Style pH probe, for installation in pipe, flow through mounting.
      - Measuring Range: 0 – 14 pH
      - Sensibility: +/- 0.01 pH
      - Temperature range: 0 to 150°C
      - Sensor model 399 manufacturer by Rosemount.
   b. Total Free Cl2 probe with the following characteristics
      - Insertion style for pipe installation, flow through mounting.
      - Measuring Range: 0 – 20 ppm (mg/L) Chlorine (as Cl2)
      - pH correction of chlorine reading.
      - Operating Temperature: 30 to 122°F
      - Sensor model 499A manufacturer by Rosemount.

D. Sensor cable length: As required for installation shown on drawings.

E. Sensor built-in electronics: Completely encapsulated for protection from moisture and humidity.

F. Provide TEE with adapter, valves and accessories.

G. Manufacturer
   1. Analyzer model 1056 manufacturer by Rosemount Analytical.
   2. Or equal.

2.06 PRESSURE SWITCH

A. The pressure-sensing element shall be a diaphragm as specified herein. The sensing element shall activate a snap acting switch. The switch connection shall be clearly and permanently marked. The assembly shall be provided with an indicating scale to show the trip setting of each switch. The switch shall be enclosed in a NEMA 4X enclosure, unless otherwise noted.

B. Provide switch in NEMA 7/9 enclosure in hazardous locations.

C. Manufacturer:
   1. Ashcroft
   2. United Electric Controls Co.,
   3. Mercoid Corp.,
4. Or equal.

2.07 FLOAT LEVEL SWITCH
A. Provide a leak-proof, shockproof, corrosion resistant float (ball) constructed of polypropylene, 316 stainless steel or other corrosion resistant material.
B. Switch assembly shall be a mercury free tilt type sensor hermetically sealed micro-switch that is activated by a moving counterweight as the switch assemble changes position in the fluid.
C. Provide switch contacts rated a minimum of 10 amperes at 115 VAC, single pole and double throw type. Furnish both normally open and closed contacts.
D. Float switch cable shall be provided with sensor as an integrated assembly. Cable shall be PVC insulated, oil resistance, and suitable for used in sewage and wastewater applications. Cable shall be sealed at the float utilizing a flexible boot and compression type lock seal.
E. Provide 3-wire cable with a minimum size conductor of No. 17 AWG.
F. Furnish the float switch cable length with continuous length to mount float switches as indicated on drawings, plus and additional 5 feet of cable. Coil and tie wrap the excess cable to mounting supports.
G. Provide wire mesh grips to support cable, unless otherwise noted, to protect against cable stress associated with constant flexing. Provide the float system with a manufacturer’s three (3) year guarantee against defects in material and workmanship.
H. Provide float switch suitable for Class 1 Division 1 for hazardous areas as indicated on contract document.
I. Manufacturer:
   1. Anchor Scientific – Eco Float
   2. MJK Automation – Model 7030
   3. Ames/Messco – SM
   4. Or equal.

2.08 ROTAMETER
A. Provide a variable area flow meter (rotameter) to measure flow of water for pump lubrication. A float within the tube rides upward in relation to amount of flow.
B. Provide a rotameter with the following characteristics:
   1. Accuracy of +/-2% full scale.
   2. 316 Stainless steel float.
   3. Polycarbonate with UV inhibitor window.
   5. Maximum pressure 100 psi.
   6. Temperature 40 to 80 F.
C. Provide mounting fitting for process connection as indicated on drawings.
D. Manufacturer:
   1. Brook Instruments, Series GT1000.
   2. Clark Solutions, Series FR5000.
3. Or Equal.

2.09 LIMIT SWITCH
A. Provide a limit type position switch on sluice gates shown on drawings to monitor the position of the gate. Refer to drawings for mounting details.
B. Switch shall have an operating voltage of 120-250 volts AC, for 2-wire operation.
C. Switch shall be suitable for submersion and be housed in NEMA 6P enclosure. Face and barrel of switch shall be stainless steel.
D. Switch shall be provided with normally open and close output contacts and adequate cable to be connected to DPCS.
E. Manufacturer:
   1. Provide Square D Model C54B2.
   2. Or equal.

2.10 DISPLAY METERS
A. The display meters shall be 120 VAC powered device with a DC input 4-20 mA. The display meter shall be a digital indicator and shall display 3.5 digits with an accuracy of +0.1% of full scale.
B. Provide a display meter for air flow meter, differential pressure transmitter and gas detector indication, as shown on the drawings. The calibrated range of the indicator should match the calibrated range of the transmitter.
C. Install the display meters in the Control Panel, as shown on the drawings.
D. Provide Red Lion Model #IMP, or equal.

2.11 SURGE PROTECTION
A. All analog instrumentation (4-20 mA loops) shall include surge protective devices located at the instrument.

2.12 HEATERS FOR EXTERIOR ENCLOSURES
A. For all exterior enclosures provide heating elements in the enclosure. Provide power necessary to power heater. Size heater for enclosure size based on 0 degrees Centigrade ambient temperature.

2.13 SPARE PARTS
A. The Contractor shall furnish to the County all necessary spare parts of components required to maintain the instrumentation system prior to final acceptance of work. The Contractor shall provide a spare parts listing of all necessary spare parts and quantities for review by the County.
B. The Contractor shall deliver to the County all the required spare parts upon conditional acceptance of the work. The spare parts shall not be used as replacement parts during the guarantee or startup period.

PART 3 EXECUTION

Refer to Section 16900.

END OF SECTION
SECTION 16942
CONTROL SYSTEM EQUIPMENT

PART 1 GENERAL

1.01 DESCRIPTION

A. This section includes requirements for the programmable logic controller (PLC) equipment and network services to be provided by the PLC manufacturer and the instrument system supplier (ISS) under Section 16900.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. General Electrical: 16010
B. Fiber Optic Cable: 16125
C. General Control Requirements: 16900

PART 2 MATERIALS

2.01 DESIGNATIONS OF COMPONENTS

A. In these specifications and on the plans, all systems and other elements are represented schematically and are designated by numbers, as derived from criteria in ISA standards. The nomenclature and numbers designated herein and on the plans shall be employed exclusively throughout shop drawings, data sheets, and the like. Any other symbols, designations, and nomenclature unique to the manufacturer’s standard methods shall not replace those prescribed above, as used herein, and on the plans.

B. PLCs shall be provided as indicated below:
   1. Water Treatment Plant PLC - WTP-PLC
   2. Booster Pumping Station - BPS-PLC
   3. Filter System – FLT-PLC, one for each filter
   4. Blowdown System – BD-PLC, one for each Clarifier
   5. Lime System – Lime-PLC.

C. This specification is based on Allen Bradley PLC. Siemens PLC are acceptable. Contactor shall provide all converter, gateways, cable, configuration, programming required for communication off all new and existing PLCs, OIT, exiting DCS, and radio equipment.

2.02 PROGRAMMABLE LOGIC CONTROLLER (PLC)

A. General
   1. Provide a solid-state Programmable Controller PLC. The PLC shall be a process and logic controller designed for industrial environments in a modular configuration.
   2. The PLC shall be a module rack unit complete with central processor, memory, Base with associated power supply, interconnecting cables, discrete and analog input/output modules and communication interface modules.
   3. The PLC and associated hardware shall have the following ratings:
      a. Temperature 0 to 55 °C ambient
      b. Humidity 5% to 95% relative humidity (non-condensing)
      c. Power 120 VAC, 60 Hz
4. The Programmable Automation Controller system shall be described and tested to operate in a high electrical noise environment.

5. I/O signals shall be provided as follows:
   a. Inputs: 120Vac, 4-20ma Analog.
   b. Outputs: Relay (some of which must have individual isolation), 4-20ma Analog, 0-10v Analog.

6. The Programmable Automation Controller shall use multiple independent asynchronous scans. These concurrent scans shall be designated for processing of input and output information, program logic, and background processing of other controller functions.

7. The Programmable Automation Controller shall have the ability to support multiple data communications networks DH-485, DeviceNet, Ethernet/IP, Modbus RTU using communications modules. Communications modules shall be provided as indicated on the system block diagram and other Contract drawings.

8. The controller shall have at least one dedicated serial port which supports RS-232-C signals. This port must be capable of local and remote (via modem) programming, troubleshooting and data manipulation.

9. The controller shall have at least one RJ-45 or Fiber Optic port which supports 10/100 Mbps Ethernet. This port must be capable of local and remote programming, troubleshooting and data manipulation.

10. The controller system shall be designed and tested to operate in high electrical noise environments.

11. Modules are defined herein as devices that plug into a rack and are keyed to allow installation in only one direction. The design must prohibit upside down insertion of the modules as well as safeguard against the insertion of a module into the wrong slot or chassis via an electronic method for identifying a module. Electronic keying performs an electronic check to insure that the physical module is consistent with what was configured.

B. Design Description

1. A major consideration of the Micro PLC system shall be its modular, field expandable design allowing the system to be tailored to the customer’s machine and/or process control application. The capability shall exist to allow for expansion of the system by the addition of hardware and/or software.

2. The Controller shall have the capability of addressing up to 960 local discrete points or 240 local analog points. The digital calculations is based upon 32 points per module * 30 local modules (maximum for CompactLogix). The analog calculations is based upon 8 channels per module * 30 local modules (maximum for CompactLogix).

3. The 30 maximum local I/O modules can be installed in up to 3 local I/O banks. Each bank will be a seamless extension to the local bank but will be electrically isolated from the other banks.

4. The Programmable Controller shall have the ability to communicate with multiple distributed I/O racks or devices configured with multiple I/O modules.

5. The Programmable Controller shall include as an optional feature the capability of addressing remote input and output modules on ControlNet and EtherNet/IP.
6. Real Time Produced/Consumed Connections can made and data seamless exchanged between multiple Controllers

7. The Programmable Controller shall use multiple independent, asynchronous scans. These concurrent scans shall be designated for processing of input and output information, program logic, and background processing of other processor functions. Input and output devices located in the same backplane (local I/O) as the CPU will be produced at the rate of configured RPI (Requested Packet Interval).

8. It shall be possible to communicate with distributed I/O racks or other PLCs via fiber optic cable by inserting fiber optic converters into the links.

9. The Programmable Controller shall have the ability to support multiple data communications links by using ControlNet, DeviceNet, Ethernet, and DH-485 networks.

10. The Programmable Controller shall have at least one dedicated serial port, which supports RS-232-C signals. It shall be accessible in control logic and provide support for DF1 Master, DF1 Point to point, DF1 Slave and DH-485 communication protocols. Alternatively, it must be usable for programming and data monitoring purposes. The serial port will also provide support for ASCII communications.

11. The Controller shall have at least one dedicated Ethernet/IP port.

C. Controller Hardware

1. The CPU shall be a self-contained unit, and will provide control program execution and support remote or local programming. This device will also supply I/O scanning and inter-processor and peripheral communication functions.

2. The user program and data shall be contained in battery backed memory. The operating system firmware shall be contained in non-volatile memory.

3. The operating system firmware can be updated via a separate update tool to allow for easy field updates. The controllers that support nonvolatile memory shall allow the operating system to be updated using a suitably configured CompactFlash card.

4. The controller memory should has as a minimum 1.5Mbytes:

5. The CPU within the system shall perform internal diagnostic checking and give visual indication to the user by illuminating a “green” (OK) indicator when no fault is detected and a “red” (OK) indicator (Blinking or Solid) when a fault is detected.

6. The front panel on the Controller shall include color indicators showing the following status information:

7. Program or Run mode of the controller

8. The fault status of the controller.

9. I/O status

10. RS-232 activity

11. Battery status

12. Force LED

13. The front panel of the Controller shall include a mounted keyswitch. The key shall select the following Controller modes: RUN – No control logic edits possible, program always executing; PROGRAM – Programming allowed, program execution disabled; and REMOTE – Programming terminal can make
edits and change processor mode, including test mode, whereby the logic executes and inputs are monitored, but edits are not permanently active unless assembled.

14. The Controller shall include a holder and a connector for a lithium battery. The battery shall provide power backup for user programs and data when the main power supply is not available.

15. The front panel of the Controller shall include at least one 9-pin D-shell serial RS232 port, which supports DF1, DH-485 (messaging only no programming) and ASCII protocols.

16. All system modules, local and remote chassis shall be designed to provide for free airflow convection cooling. No internal fans or other means of cooling, except heat sinks, shall be required.

17. The Controller shall include an integrated Real Time Clock (RTU). This clock value should be in a form of a predefined tag and should be accessible via logic or remotely.

D. Power Supplies

1. The Programmable Controller shall operate in compliance with an electrical service of 85 to 132 VAC or 120 to 220 VAC, single phase, in the frequency range from 47 to 63 Hz, or 16-32 VDC or 19.2 to 32 VDC.

2. The manufacturer shall be able to provide as standard equipment a system power supply capable of converting AC standard low voltage line power to the DC power required to operate the Programmable Controller system.

3. A single main power supply shall have the capability of supplying power to the CPU and local input/output modules. Other power supplies shall provide power to remotely located racks.

4. The power supply shall automatically shut down the Programmable Controller system whenever its output power is detected as exceeding 125% of its rated power.

5. The power supply shall monitor the incoming line voltage for proper levels. When the power supply is wired to utilize AC input, the system shall function properly within the range of 85 to 265 VAC. When the power supply is wired to utilize DC input, the system shall function properly within the range of 19.2 to 32 VDC. In addition, the power supply shall provide surge protection, isolation, and outage carry-over up to 2 cycles of the AC line.

6. Design features of the Programmable Controller power supply shall include a diagnostic indicator mounted in a position to be easily viewed by the user. This indicator shall provide the operator with the status of the DC power applied to the backplane. In addition, a means of disabling power to the CPU shall be possible from a power disconnect switch mounted in a position easily accessible by the operator.

7. At the time of power-up, the power supply shall inhibit operation of the processor and I/O modules until the DC voltages of the backplane are within specifications.

8. In addition to the electronic protection described above the power supply shall offer a failsafe fuse that is not accessible by the customer.

E. Inputs / Outputs

1. General

   a. The system must support as a minimum 16 I/O expansion modules.
b. Isolation shall be between all internal logic and external circuits.

c. Each input and output point shall have a visual indicator to display ON/OFF status.

d. All user wiring to I/O modules shall be through a heavy-duty terminal strip. Pressure-type screw terminals shall be used to provide fast, secure wire connections.

e. Inputs shall have adjustable filter time constants to improve input performance in high speed applications, and to limit the effects of voltage transients.

2. The controller manufacturer shall offer input/output hardware consisting of the following types:

   a. **Standard Inputs:**
      - DC inputs for devices which operate at 24V.
      - AC inputs for devices which operate at 120V, 50/60 Hz.
      - Analog inputs for devices which operate at 4-20mA, or -10 to +10Vdc

   b. **Standard Outputs**
      - Relay outputs for DC devices which operate at 5 to 125Vdc, with 2 amp continuous current capacity at 24Vdc, and 1 amp continuous current capacity at 125Vdc.
      - Relay outputs for AC devices which operate at 5 to 264Vac with 2.5 amp continuous current capacity.
      - Analog output for devices which operate at 4-20mA or –10 to +10Vdc

F. Program Creation and Storage

1. The program storage medium shall be of a battery backed RAM.

2. Memory shall contain battery back-up capable of retaining all stored program data through a power failure. A low battery condition must be detectable in ladder logic, but shall not automatically generate a major fault. A low battery condition will generate a minor fault and will be detectable in ladder logic and will be indicated on a diagnostic indicator mounted on the front of the controller.

3. The controllers shall provide the capability to use CompactFlash card as nonvolatile memory storage. The user can manually trigger the controller to save or load from CompactFlash Card and also configure the controller to load from CompactFlash Card on power up or when an issue is detected with the data in RAM.

4. The operator should be able to backup volatile memory, including data, and program logic onto a CompactFlash Card storage device. In addition, the controllers current firmware should also be stored on the CompactFlash card.

5. All user memory in the processor not used for program storage shall be allocable from main memory for the purpose of data storage. The Programmable Controller system shall be capable of storing 3 data types:

   a. Predefined
   b. User-defined
   c. Module-defined
9. Control logic programs shall have immediate access to the subelements of control structures by address and subelement mnemonic, such as timer accumulator value, timer done bit, or PID Process Variable value.

10. Data in the controller should be user defined and tag based and not restricted to any fixed data register format

G. Interfacing and Peripherals

1. The programming software shall be on a Windows 2000 or Windows XP workstation.

2. The programming software shall have the capability to be remotely located from the processor over EtherNet/IP, ControlNet, or DH-485. The workstation shall also be able to connect via Ethernet or RS232 for remote access.

3. The workstation should be able to edit and modify logic without having to take the controller off-line. Provide the ability for changes to be tested and verified prior to merging with existing logic.

4. The system shall have the capability to interface to a floppy disk and/or a hard disk for loading a user program into, or recording the contents of, the processor's memory. It shall be possible to load or record the entire contents of memory.

H. Communication Interfaces

1. The Programmable Controller shall have integrated EtherNet/IP, ControlNet, or DH-485 and communication interface modules DeviceNet and RS232.

2. The Integrated EtherNet/IP interface shall support the following:
   a. IEEE802.3 Physical and Data Link Standard
   c. Common Industrial Protocol (CIP), the protocol that provides real-time I/O messaging and information/peer-to-peer messaging
   d. Standard TCP/IP communications
   e. 10/100M/Baud auto sensing and auto switching
   f. Standard Ethernet media (10base and 100 base, copper and fiber)
   g. Subnet masking
   h. Switches, standard repeaters, bridges, routers, host computers, peer PLCs.
   i. RJ-45 and AUI ports
   j. Full or Half-Duplex communication

I. Programming Techniques

1. The programming format shall be IEC 1131-3 compliant Ladder Diagram (LD), Function Block Diagram (FBD), Sequential Function Chart (SFC).

2. The controller shall organize user applications as Tasks, which can be specified as continuous, periodic, or event based.

3. Periodic tasks shall run via an interrupt at a user-defined interval in one microsecond increments from 1 millisecond to 2000 seconds.
4. The periodic and event tasks shall have an associated, user assignable priority from one to fifteen (one being the highest priority), which specifies that task’s relative execution priority in the multitasking hierarchy.

5. The event task can be triggered by software events (event instruction).

6. Each task shall have a user settable watchdog timeout which is unique to that task.

7. Each program can include routines programmed in LD, FBD or SFC languages. One of the routines can be specified as the main routine and one can be specified as an optional fault routine. All routines shall be capable of being edited when on-line.

8. Variables within the controller shall be referenced as unique, default or user defined tags.

9. Tags may be created off-line, on-line and at the same time the routine logic is entered.

10. The system shall have the capability to store a description for each tag.

11. Tags shall be available to all tasks in the controller (Controller Scoped) or limited in scope to the routines within a single program (Program Scoped) as defined by the user.

12. The system shall have the capability to address software timers and software counters. All management of these instructions into memory shall be handled by the CPU. Instructions shall permit programming timers in the “ON” or “OFF” delay modes. Timer programming shall also include the capability to interrupt timing without resetting the timers. Counters shall be programmable using up-increment and down-increment.

13. The Programmable Controller shall use a signed double integer format ranging from -2,147,483,648 to +2,147,483,648 for data storage of the counter preset and accumulated values.

14. The Programmable Controller shall store data in the following formats:
   a. Boolean values (0 or 1).
   b. Short Integer Numbers ranging from -128 to +127.
   c. Integer Numbers ranging from -32,768 to +32,767.
   d. Double Integer Numbers ranging from –2,147,483,648 to +2,147,483,647.
   e. Floating Point Numbers consisting of eight significant digits. For numbers larger than eight digits, the CPU shall convert the number into exponential form with a range of plus/minus 1.1754944 E -38 to plus/minus 3.402823 E +38.

15. The Programmable Controller shall have support for integer and floating point signed math functions consisting of addition, subtraction, multiplication, division, square root, negation, modulus, and absolute value.

16. It shall be possible to complete complex, combined calculations in a single instruction, such as flow totalizing or equations of the format ((A+((B-C)*D))/E).

17. Arrays shall be configurable with one, two or three dimensions.

18. The CPU shall support indexed addressing of array elements.

19. The Programmable Controller shall provide a master system.
20. In applications requiring repeatable logic it shall be possible to place such logic in a subroutine section. Instructions which call the subroutine and return to the main program shall be included within the system. It shall be possible to program several subroutines and define each subroutine by a unique program file designator. The processor will support nesting of subroutines up to available stack at the moment of the call. It shall be possible to pass selected values (parameters) to a subroutine before its execution.

21. The system shall have the capability to enter rung comments above ladder diagram rungs. These comments may be entered at the same time the ladder logic is entered.

22. The capability shall exist for adding, removing, or modifying logic during program execution in routines of LD, FBD, SFC languages. When changes to logic are made or new logic is added it shall be possible to test the edits of such logic before removal of the prior logic occurs.

23. It shall be possible to manually set (force) either on or off all hardwired discrete input or output points from the programming panel. It shall also be possible to manually set (force) an analog input or output to a user specified value. Removal of these forced I/O points shall be achieved either individually or totally through selected keystrokes.

24. A means to program a fault recovery routine shall exist. When a major system fault (Controller Fault) occurs in the system, the controller fault recovery routine shall be executed and then the system shall determine if the fault has been eliminated. If the fault is eliminated, program execution resumes. If the fault still exists, the system will shut down.

25. An instruction shall be available to give the control program diagnostic information, state control, and sequencing of a process simultaneously, while allowing the capability of user-friendly state programming techniques.

J. Manufacturer
1. Provide CompactLogix PLC Manufacturer by Allen Bradley.
2. For Siemens PLC Provide a S7-200 series.

2.03 CONTROL SYSTEM NETWORK
A. General
The control system network shall consist of four different communications protocols.
1. PLCs, OITs shall communicate via Ethernet network, Fiber Optic Cable or Cat 5 shielded cable as shown on drawings.
2. Information will be transmitted to and from computers operating the MMI platforms via an Ethernet local area network.
3. Power monitors will communicate to PLCs via Ethernet Network.
4. Existing Broad Creek I WTP Modicom Quantum PLC will communicate to the Broad Creek II WTP PLC via Modbus plus network, through existing fiber optic cable.

B. Ethernet Network
1. Ethernet communications interface module shall provide for PLC communication. The PLC shall communicate as shown on drawings.

C. Modbus RTU and Plus Communication
1. Provide a Prosoft Module to be installed in the PLC rack for Modbus plus communication with the existing Broad Creek I PLC.

2. Provide a Prosoft Module to be installed in the PLC rack for Modbus communication with the existing DCS system.

3. Communication to the Master Radio shall be through a RS232/485 communication port.

4. Provide and install physical media in accordance to contract drawings. Provide connectors and link couplers required to integrate a complete the Modbus communication.

2.04 OPERATOR INTERFACE TERMINAL (OIT)

A. Operator interface terminal shall be provided which will be a panel mounted electronic assembly that allows bi-directional communication between the programmable logic controller and the operator interface.

B. The operator interface terminal shall have a 10-inch, color display with at least 640 x 400-pixel resolution, and touch screen capability. The operator interface terminal will employ flash memory for storing the application-specified symbols and data. The unit will allow up to 160 touch areas per screen display and a minimum of 12 screens. Each touch area will provide audible feedback to the operator.

C. Screens will be configured using an off-line PC based software package that runs in the Microsoft Windows environment. Each display screen will consist of graphic representations of legend plates, pushbuttons, pilot lights, numeric data displays, numeric data entry buttons, bar graphs, time displays, dynamic text displays, selector switches, illuminated pushbuttons, counter numeric preset and increment/decrement buttons. In addition, the unit will be capable of displaying bit map graphics in at least two (2) colors. Graphics can be created using any software that produces or converts to standard Windows .bmp files. Applications will be downloaded to the operator interface and stored in the flash memory.

D. The operator interface terminal shall be capable of display text messages that can be triggered by the status values of bits or numeric variables in the programmable logic controller. In addition, the unit must be capable of accepting and displaying text messages that are stored in the programmable logic controller as ASCII strings.

E. The operator interface terminal shall be provided with the interface and cabling necessary to communicate with the PLC via Ethernet. Additionally, the contractor shall provide all cabling necessary to program the PLC locally without disconnecting the OIT or Ethernet connection.

F. A Windows based configuration and development software package shall be provided on a CD to develop graphics, database tables, and to configure the operator interface terminal.

G. Operator interface terminal shall be a Panelview 1000 manufactured by Allen Bradley or equal Operator Terminal manufacturer by Siemens.

2.05 MANAGED ETHERNET SWITCH

A. Provide industrial 10/100 FX/TX management Ethernet switch for integration of the local control station networks.

B. The switch shall meet the following requirements:
   1. Complies with Standards IEEE 802.3 and 1 for 10BadeT, 100 BaseTX and 100BaseFX, flow control, VLAN tagging, Class of Service, Authentication
   2. Protocols:
a. TCP/IP protocol  
b. Multicast filtering  
c. IGMP snooping  
d. VLAN  
e. Port security  

3. Interface:  
a. Fiber Port: 100Base/FX ports (SC connector)  
b. RJ45 Port: 10/100BaseTX  
c. Console port: RS-232  

4. Led indicators Power, Fault  

5. Power:  
a. 24VDC or 120 VAC, 60 Hz.  
b. If 24 VDC switch is provided, provide dual configuration power supplies.  

6. Alarm Contact: 1 alarm contact for 120 VAC, 2 amp  

7. Provide mount kit for installation as shown on drawings  

C. Provide Ethernet switch with the following ports as a minimum:  
1. 24 Port switch with 6FX/18TX ports for Ethernet switches at WTP-PLC enclosures. Model S6726.  
2. 16 Port Switch with 2FX/14TX ports for Ethernet switches at the Control Panel Room. Model ESD-516A  
3. 8 Port Switch with 2FX/6TX ports for Ethernet switches at the Lime System, WBS-PLC and WTP-ITC. Model ESD-508A.  

D. Manufacturer  
1. Provide Ethernet Switch manufacturer by MOXA, or equal.  

2.06 SPARE PARTS  

A. The Contractor and Instrument System Supplier (ISS) shall furnish to the representative of the Owner all necessary spare parts of components required to maintain the system. Prior to final acceptance of work, the system supplier shall provide a spare parts listing of all necessary spare parts and quantities for review of the representative of the Owner. The spare parts shall include, but not be limited to, the following minimum requirements.  

B. PLC Equipment:  
1. Power Supply 2 of each type  
2. Analog Output Module 2 of each type  
3. Analog Input Module 2 of each type  
4. Discrete Output Module type 2 of each type  
5. CPU Module 1 of each type  
6. I/O Chassis Assembly 1 of each type  
7. Operator Interface Terminal 1 of each type  
8. Communication Interface Module 1 of each type
PART 3 EXECUTION

3.01 REFER TO SECTION 16900.

END OF SECTION
PART 1 GENERAL

1.01 DESCRIPTION
A. This section includes requirements for materials, and installation of the cabinets, control panels and consoles to be provided by the instrument system supplier under Section 16900.

1.02 RELATED WORK SPECIFIED ELSEWHERE
A. General Electrical: 16010
B. General Control System Requirements: 16900

PART 2 MATERIALS

2.01 NEMA 12 CABINETS AND ENCLOSURES
A. The NEMA 12 cabinets and enclosures shall be floor or wall mounted enclosures, unless otherwise shown, suitable for a damp and dusty environment. Access door shall have continuous hinges with neoprene gaskets, with 3-point latch system. Cabinets shall be constructed from formed 12-gauge steel. All exposed edges and welds on the enclosure shall be ground smooth.
B. The exterior of the enclosure shall be painted with a rust-inhibiting primer and two coats of epoxy gray paint.
C. The interior shall be provided with a formed 12-gauge subpanel for attaching surface-mounted components and a hinged subpanel for front panel mounted hardware. All components shall be attached with screws and the subpanel shall be threaded. Rivets on back of panel nuts shall not be allowed. Each interior shall be equipped with an incandescent lamp, 120-volt 15-ampere duplex GFI receptacle and two single-pole, 15-ampere, 120-volt circuit breakers. One circuit breaker shall be for the lights and outlets. The other circuit breaker shall be for the PLC and instrumentation equipment. The interior shall be painted with two coats of white enamel paint. Refer to instrumentation drawing for enclosure size and installation details. The NEMA 12 cabinet shall be a Hoffman NEMA 12, or equal.

2.02 NEMA 4X CABINETS AND ENCLOSURE
A. NEMA 4X cabinets shall be floor-mounted or wall mounting as shown on the drawings. Fabricated from stainless steel or fiberglass, as specified. Access door shall have continuous hinge and hasps for locking.
B. Interior requirements shall be the same as NEMA 12 enclosure. The NEMA 4X cabinet shall be Hoffman NEMA 4X, or equal.

2.03 UPS SYSTEM
A. Provide an on-line UPS to protect the PLC from line disturbance, subcycle power losses, and power outages. In normal operation, the a-c power shall be rectified to d-c power. The d-c power from the charger shall maintain the batteries at full charge. When line power fails, the inverter shall change the battery d-c power pack to a-c while it regulates and provides a sine wave power to the load. The load shall automatically transfer to the inverter a-c line in less than 10 milliseconds. The UPS shall be complete with power indication, inverter circuit breaker protection, power fail, and low battery alarm relay contacts. Batteries shall be sealed, leakproof and maintenance free, mounted in a separate battery rack. UPS unit shall come complete with internal battery charger and battery connect cables.
B. The UPS system shall have the following requirements:
   1. Input/Output Voltage: 120-volt a-c, single phase 60 Hz.
   2. Minimum Output Rating: 1000 VA at each PLC Cabinet or OIT; 750 VA at RIO Cabinet.
   3. Output Harmonic Distortion: 5% maximum at full load.
   4. Frequency Stability: +/-0.5%.
   5. Overload Capacity: 125% for 10 minutes.
   6. Maximum Charge Rate with Load: 20 amperes.
   7. Minimum Run Time: 30 minutes at half load.

C. A shelf mounting bracket assembly shall be provided for mounting the UPS inside PLC cabinets, unless otherwise noted.

D. The UPS systems shall be manufactured by Eaton Powerware or equal.

2.04 PENDANT ARM SYSTEM

A. Provide a Cast aluminum coupling and extruded aluminum pendant Arm system at the location shown on drawings.

B. The pendant Arm system shall consist of the following:
   1. Tubes.
   2. Wall joint
   3. Intermediate joint
   4. Elbow
   5. Swivel tilt
   6. 14 gauge steel operator interface enclosure with integral handle, and aluminum front plate
   7. Support brackets

C. Provide Pendant Arm system to support the load weight and size the operator interface enclosure based on the Operator Interface Terminal (OIT) to be provided. Refer to Specification Section 16942 for OIT specifications.

D. Provide mounting bracket and accessories for a complete system.

E. Provide the following:

F. Compact Pendant Arm System Series 4 and Concept Operator Interface enclosure Hoffman Bulletin C2 or equal

2.05 PANEL CONTROL CIRCUIT DEVICES AND COMPONENTS

A. General: All components, except those on the front panels, shall be mounted behind on fixed or swing-out panels; terminal blocks for field connections shall be mounted on fixed channels located near the bottom of the sections but clear of the conduit entry area. Fixed panels shall be located so as not prevent access within the cabinets to other components, wiring, and terminal blocks on fixed panels or front panels.

B. Control Relays: Control relays shall have either 24-volt d-c or 120-volt a-c coils. Control relays shall be 10-ampere, 300-volt, DC relays shall be blade type and AC relays shall be pin type with dust cover, LED indication, and sockets. All relays shall be of one manufacturer; Struthers-Dunn, Potter-Brumfield, or equal.
C. Circuit Breakers: Circuit breakers shall be din rail mounted, single-pole, 120 volt, 15-ampere rating.

D. Wire marking: Each signal and circuit conductor connected to a given electrical point shall be designated by a single unique number which shall be shown on all shop drawings. These numbers shall be marked on all conductors at every terminal using white numbered wire markers which shall be Thomas & Betts sleeve markers, T&B Shrink-Kon, or equal.

E. Terminal Blocks: Terminal block shall be high-density type molded plastic with barriers and box lug terminals and shall be rated 25 amperes at 300 Volts. White marking strips, fastened securely to the molded sections shall be provided with printed wire numbers or circuit identifications. Terminal screws will be accessible with a standard size narrow blade screwdriver. Provide minimum 25% spare terminal blocks mounted in each cabinet. Terminal blocks shall be Phoenix Contact Type UK with mounting rail or equal.

F. D-C Power Supplies: Provide dual d-c power supplies with relay monitored backup at all locations requiring d-c circuits. Each power supply shall be enclosed and include internal short-circuit protection. Current requirements of connected equipment shall not exceed 75% of manufacturer maximum rating.

G. Receptacles: Duplex receptacles shall be molded composition, ivory, specification grade. Duplex receptacles for 120-volt, single-phase, 3-wire service to be rated 20 amperes, 125 volts, back or side wired, NEMA Type 5-20R. Provide ground fault interrupter type where indicated.

H. DC Signal Conditioner: Provide a DC Signal Conditioner where required to drive or isolate loads. The signal conditioner shall have input and output ranges compatible with the associated equipment. The DC input/output isolation shall allow up to 600 V differences between grounds. The conditioner shall have an accuracy of +/-0.1% of input span, a zero and span adjustment and a maximum response time of 100msec. The operating temperature range shall be 0 to 60 degrees C. Power for the signal conditioner shall be 120 VAC at 60 Hz. Provide an Action Instruments Action Pak Model 4300, or equal.

I. Push Buttons, Selector Switches, and Indicating Lights: Push buttons, selector switches, and indicating lights shall be heavy duty, 30.5 mm, oiltight type with synthetic rubber boots and include any special gasketing required to make the installation watertight. Indicating lights shall be push-to-test transformer type. Provide Allen-Bradley Bulletin 800H; Square D Class 9001, Type SK; or equal.

J. Transient Voltage Surge Suppressor: The AC power line protector shall be a solid state low pass non-linear filter to protect the cabinet equipment from spikes, transients, and noise on incoming AC power lines. The protector shall be rated 120 volts A-C, 15 amps, 60 Hz. Refer to section 16670 for specifications.

K. I/O Signal Surge Suppressors

1. Surge suppression shall be provided for each analog signal which exits the room/building where the PLC cabinet is installed. Refer to Specification Section 16670.2.04.

2. Surge suppressors shall be mounted on a universal mounting rail. They shall be wired in the circuit so as to protect the PLC equipment from electrical transients whose source is external to the enclosure.

3. Surge suppressors shall be rated at the nominal power supply voltage of the circuit they are protecting.

4. Digital I/O signal surge suppressors shall meet the following:
a. Common power for the input points on each input module shall be protected from incoming transients by the furnishing of a surge suppressor the PLC input and the incoming signal. The surge suppressor shall as a minimum include a gas filled discharge tube, a metal oxide varistor and a series coil. The maximum series resistance at 100 Hz shall be 50 Ohms. At one megahertz at least 30 decibels of attenuation shall be provided. The rated operating current shall be one to two Amps.

L. Panel Heating Devices
1. Furnish thermostatically controlled fan-driven electric heater units on enclosures mounted in exterior locations. Heaters shall be capable of maintaining an inside air temperature of 50 degrees F based on an outside air temperature of 30 degrees F. Air sensing thermostats shall be adjustable from 0 degrees F to 100 degrees F. Heaters shall be Hoffman Designaire, or equal.

M. Intrinsically Safe Relay/Barrier
1. An intrinsically safe relay/barrier shall be installed in the control panel for all switching devices located in hazardous locations.

2.06 PANEL CONTROL CIRCUIT WIRING
A. Instrumentation signal cables shall be of the type used for process control with shielded pairs or triads with polyvinyl jacket and overall shield over the multiple pairs or triads. The instrumentation cable shall be rated 300 volts at 90 C or better. The size of the instrumentation cable shall be AWG No. 16 with seven strands minimum, unless otherwise specified elsewhere. All instrumentation cables shall meet all the requirements of IPCEA S-61-402 and shall be UL listed.

B. 120-volt a-c wiring within the panel shall be AWG No. 14 MTW or THHN. Main power (120-volt a-c) to the panels shall be wired using color coded AWG No. 12. A-C power to all system power supplies, CRTs, printers, and computers, shall be accomplished using molded 3-wire plug cords.

C. Wires shall be color coded in accordance with the following:
1. BLACK L1(hot)
2. WHITE L2(neutral)
3. RED a-c control circuits
4. BLUE d-c circuits
5. YELLOW Interlock control circuits wired from an external power source
6. GREEN Equipment ground

D. All interfacing between the cabinet and the field shall be accomplished at a terminal strip (TB-1). No internal panel wiring shall be connected to terminals on the “field side” of TB-1. Likewise, no field wiring shall be connected to terminals on the ‘panel side’ of TB-1.

E. Wiring run from components on a swing-out panel to other components on a fixed panel shall be made up in tied bundles. These shall be tied with nylon wire ties and shall be secured to panels at both sides of the hinge loop so that conductors are not strained at terminals.

F. Wiring run to control devices on the front panels shall be tied together at short intervals and secured to the inside face of the panel using Panduit adhesive mounts with Eastman No. 910 adhesive.
G. Wiring to rear terminals on panel-mount instruments shall be run in plastic wireways secured to horizontal brackets run above or below the instruments in about the same plane as the rear of the instruments.

H. Conformance to the above wiring installation requirements shall be reflected by details shown on the shop drawings for the Engineer’s review.

I. Signal conditioners and control interface relays shall be provided wherever proper instrument interfacing dictates use of these components. Each auxiliary device shall be assigned a tag number and shall appear on the panel shop drawings.

J. All electrical devices within the panel shall be identified by tag number, machine printed on a label visible from the panel interior. Labels shall be laminated plastic with an adhesive backing. The labels shall be consistent in size throughout the panel.

K. All electrical devices within the cabinet, or fed from the cabinet, shall have independent disconnecting means with overcurrent protection.

L. All panels shall be fabricated by a system supplier who is a recognized Underwriter’s Laboratories (UL) Industrial Control Panel Fabricator. Each panel shall include certification and a label which states that it has been fabricated within the standards of UL 508 for non-hazardous installations and UL 698A for hazardous installations. Only labeled panels produced by recognized UL panel manufacturers shall be considered acceptable for use on the project. NEMA ratings for enclosures shall be retained with UL Certification.

2.07 RTU RADIO SYSTEM

A. Equipment

1. Provide a 900 MHz Master/slave radio system Multi-Point to Point, Monitoring and Control Modules. Master radio with five remote slave radios.

2. Modules shall be either capable of mounting to DIN rail or wall. DIN rail mounted modules shall have the option of being mounted on either a horizontal or vertical, mounting rail.

3. DIN rail mounted modules shall be capable of being installed side by side, with no gap or air space required for heat dissipation, with no loss of accuracy.

4. The module shall be approved for use in the 902-928 MHz, ISM bandwidth, under FCC rules part 15.247, and the ISC RSS 210 rules.

5. The module shall incorporate Frequency Hopping, Spread Spectrum technology to maximize interruption free transmission. In addition, robust interference rejection must be insured by the use of traditional narrow band filtering techniques to reject noise and interference.

6. Routing table generation capability for MODBUS RTU, and Allen-Bradley DF1 serial communication protocols shall be available in the radio to ensure system compatibility.

7. Modules shall utilize a windows based GUI software program for configuration and diagnostics.

8. Wireless networks shall be configured using an all inclusive set up wizard for complete system interoperability, or individual radios can be programmed for Master, Slave, or Repeater functionality.

9. The programming software shall include the ability to monitor and display the entire network and provide diagnostic information to the user. Monitoring information shall include a minimum of: Received Signal Strength Indication (RSSI), and Dropped data packets.
10. Monitor alarm notification shall be via sounds, visual displays.
11. Network configuration reporting can be previewed on screen and printed.
12. Modules shall be interchangeable as either a Master, Repeater, or Slave.
13. Communications between the master site and all remote sites must be direct and 100% transparent communications to all standard asynchronous protocols.
14. Transmit Power shall be the FCC maximum of 1 Watt. The radio must be capable of hopping over at least 25 separate frequencies from 902 to 928MHz. In addition the radio must have a minimum of 65,000 separate security code addresses.
15. A test point for measuring RSSI shall be incorporated into the Transceiver modules.
16. The radios must be capable of interfacing to the users equipment at data rates 9600, 19200, 38400 bits per second.
17. The module shall have RS232, and/or RS485 as option for serial communication interface protocols. Master radio shall communicate with the PLC RTU via a Ethernet switch. Provide all devices to make this connection.
18. Each remote location shall transmit one 4-20 mA and two discrete signals. As a minimum the system shall be able to add one analog and digital signal.
19. The module shall have a RF Link status relay output integrated in the unit. The relay contact shall be Normally Open, rated for 1A at 30Vdc.
20. The module shall be powered with a DC supply voltage between 9 and 30 VDC (24 VDC nominal).
21. Provide Omni base station and directional remote station antennas with ground kits, type N (F) connectors and antenna cables. Cable length shall be provided based on radio/antenna installation.
22. Provide antenna surge protection. Provide antenna, surge protection and cable connectors type N.
23. Provide 24 VDC power supply, TVSS surge suppressor, mounting rail terminal blocks circuit breaker and cables.
24. Provide a radio enclosure NEMA 4X.
25. Perform a radio field test to ensure installation of the radio system with strength signal between remote sites to the master site.
26. Provide Point to Multipoint Serial Data module radio system manufacturer by Phoenix Contact or equal. Design is based on RAD ISM 900 radio system manufactured by Phoenix Contact. Any deviation is responsibility of contractor to include at not additional cost.

B. Wire Connections.
1. Wires shall be attached to DIN rail mounted modules by pluggable terminal blocks that accept wire sizes from 24 to 14 AWG.
2. Pluggable terminal blocks will be keyed to help prevent incorrect positioning of the plug in the DIN rail mounted modules.
3. Clearly label each terminal block and cable.
C. Installation

1. Installers shall be knowledgeable, and if required, certified, in all applicable electrical practices, standards, codes and wiring techniques as they pertain to installing analog instrumentation.

2. Installers shall follow all applicable safety standards and perform work on only de-energized electrical systems.

3. Installers shall follow manufacturer's installation instructions provided with instrumentation.

4. Transmit Power shall not be less than or greater than 1 Watt (30 dbm).

PART 3 EXECUTION

Refer to Section 16900.

END OF SECTION
PART 1 GENERAL
1.01 DESCRIPTION
A. The loop descriptions, together with the drawings comprise the functional design criteria of the instrumentation and control system. The control description drawings and other specification sections shall be utilized for construction.

1.02 SYSTEM SUPPLIER
A. The system supplier shall utilize the loop descriptions and drawings as the basic criteria for the design of the instrumentation, schematics, preparation of the data sheets, wiring diagrams, piping layouts, assembly drawings, and other requirements set forth in these specifications.

PART 2 CONTROL DESCRIPTION
2.01 EXISTING EQUIPMENT AND UPGRADES
A. The existing Broad Creek II water treatment plant has a capacity of 4 mgd and consists of five off site well pumps, two aerators, rapid mixer, two clarifiers with blow-down valves and two vacuum pumps, one filter with four gravity filter-cells, one clearwell with three clearwell pumps, one ground storage tank, one booster pumping station with three booster pumps, one transfer tank with two transfer pumps, one decant tank with a drive, one sludge tank with two sludge pumps, one lime feed system which consists of two independent storage/feed systems, sodium hypochlorite feed system, fluoride feed system, polymer feed system, flow meters, pressure transmitter, level controls, pH analyzer, chlorine residual analyzer, and appurtenances.

B. The Plant capacity will be expanded to 8 mgd, therefore the following new equipment will be installed:
   1. Two aerators.
   2. One clarifier flocculator
   3. One vacuum clarifier
   4. One greenleaf filter with four filter cells.
   5. One clearwell with three clearwell pumps.
   6. Two residual clarifier feed pumps
   7. Two recycle pumps.
   8. Modify existing decant tank with a Residuals Clarifier drive mechanism.
   9. Three polymer feed systems
   10. One hypochlorite bulk tank.

C. The existing Lime System will be modified to a High Density Lime System; the following equipment will be installed:
   1. Add bin activator and knife gate valves at the existing lime silo discharges.
   2. Two screw conveyors, one for each silo.
   3. Two weigh tanks with its associated transfer pump.
   4. One day tank
5. Three lime metering pumps.

D. With the addition of new clarifier, filter and clearwell process, two operational trains can be defined for plant treatment. If one train is set as Out of service by the operator at the HMI, the WTP-PLC will automatically set Out of Service, all the equipment associated with that train.

2.02 PROGRAMMING DESIGN CRITERIA

A. The Control programming will be design based on the following criteria:

1. Equipment Configuration: Some of the equipment will operate in Lead/ Lag/ Standby or Lead/Standby operation mode.

2. Operation mode: Equipment will operated in the following modes:
   a. Remote/Auto: In automatic mode, the PLC will control the operation of the respective equipment based on the PLC programming.
   b. Remote/Manual: In manual mode, the operator will control the operation of the respective equipment through the HMI.
   c. Local: In local mode, the operator will control the operation of the respective equipment through the local control panels or local control stations at the field.

3. Equipment status: The equipment will have the following operational status:

<table>
<thead>
<tr>
<th>Status</th>
<th>Description</th>
<th>Color-Code</th>
</tr>
</thead>
<tbody>
<tr>
<td>In Fail</td>
<td>Equipment is in failure condition and not available for operation</td>
<td>Green with “Fail” text indication.</td>
</tr>
<tr>
<td>Running</td>
<td>Equipment is running</td>
<td>Red.</td>
</tr>
<tr>
<td>Ready</td>
<td>Equipment stop, ready to run and not in fail condition</td>
<td>Green</td>
</tr>
<tr>
<td>Out of service</td>
<td>Equipment out of sequence by the operator or alarm condition. The equipment can be set by the operator to “Out of Service” when in maintenance</td>
<td>Blue</td>
</tr>
</tbody>
</table>

4. If a equipment is set in fail an alarm will be displayed at the DCS workstation and the WTP-PLC will automatically perform the following:
   a. Lockout the equipment of sequence. The PLC will automatically set the equipment Out of Service until the fail condition is clear.
   b. Start the next equipment in sequence.

5. Pump Matrix Configuration: a pump matrix is configured in the existing PLC to allow the operator to configure the sequence of operation of pumps. An example of the existing pump matrixes is shown on Table 2.

   Table 2 –Pump Matrix Configuration

<table>
<thead>
<tr>
<th>Pump</th>
<th>Step 0</th>
<th>Step 1</th>
<th>Step 2</th>
<th>Step N</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
6. The matrix is defined as X*Y, where X is the number of pumps and Y the number of steps based on the levels or pressure process variables. The difference between the measured process variable and the set-point determine if the control process goes forward (step 0, step 1, step 2, ..., Step N) or reverse (step N, ..., step 2, step 1, step 0) through the matrix. A time delay is defined between steps.

7. Time delays: Time delays for alarm and control are defined at the PLC. The operator adjusts these variable though the DCS workstation.

8. Alarm/Control Set-point: The operator adjusts the alarm and control set-points either from the DCS workstation or OITs, the adjustment is updated automatically at the other location.

9. Equipment Run time will be calculated by the PLC, based on time in operation.

10. Password is set at the DCS workstation and OIT for set-point modifications by the Operator.

11. Graphics/Displays: Graphics of the process will be set at each OIT for monitoring and control. Graphics at the DCS workstation will be programming by the Owner.

12. Alarms: A summary of the alarms will be set at each OIT. Alarms at the DCS workstation will be programming by the Owner.

2.03 HUMAN MACHINE INTERFACE

A. The existing HMI consists of one DCS workstation and two Operator Interface terminals (OITs). As part of the expansion the following modification will be accomplished:

1. The DCS workstation is located in the existing electrical room for operation and monitoring of the Broad Creek II Water Treatment Plant and other sites (Central Heritage, Harbor and Rosehaven plants). The existing DCS workstation consists of a SUN workstation with Solaris Ver 9.0 and Qualitol SCADA software. The Workstation will remain and new displays will be provided by the County for control and monitoring of the newly installed equipment as part of the plant expansion.

2. The exiting OITs are located at the Booster Pumping Station and the Water Treatment Plant PLC enclosures for monitoring and control of each area. These OIT will be removed and three new OITs will be provided as follows:
   a. At the Booster Pumping Station PLC enclosure
   b. At the WTP-ITC enclosure
   c. At the Control Panel Room Communication Cabinet

2.04 WELL PUMPS

A. Raw water from existing wells 1 thru 5 can be treated at Broad Creek Water Treatment Plant I or II. Each well is controlled by its own PLC located at the well. The well PLCs communicates with the BC-WTP II PLC via spread spectrum radio communication. New wells 6 thru 8 will be configuration similar to the existing ones. One PLC control panel will
control Well 6 and another PLC control panel will control the other new two wells, Wells 7 and 8.

B. Existing Well Pumps 4 and 5 have a variable frequency drive. New Well Pumps 6 thru 8 will have variable frequency drives as shown on drawings.

C. A well matrix 5x5 is currently set at the DCS for operator Lead/Lags pumps selection at the HMI. The operator can select any pump as a Lead or Lag. A total of 4 well pumps can run at the same time with the exception of Wells 4 and 5 because they exceed the current plant treatment capacity of 4 mgd. Well Pumps 4 or 5 can be set as lead pump only.

D. Existing well pump matrix 5x5 will be expanded to a 8x8 matrix with the addition of wells 6 thru 8. The new matrix is shown on Table 3.

E. Table 3.- New Well Matrix 8x8

<table>
<thead>
<tr>
<th></th>
<th>Well 1</th>
<th>Well 2</th>
<th>Well 3</th>
<th>Well 4*</th>
<th>Well 5*</th>
<th>Well 6*</th>
<th>Well 7*</th>
<th>Well 8*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lag 1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lag 2</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lag 3</td>
<td></td>
<td></td>
<td></td>
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<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Lag 4</td>
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<td></td>
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<td></td>
</tr>
<tr>
<td>Lag 5</td>
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<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Lag 6</td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Standby</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Pumps with VFDs

With the expansion of the plant capacity to 8mgd, the operator will be able to select any pump as Lead/Lags and Standby.

F. The Operator enters the Influent Flow set-point on the HMI for system operation.

G. The well pumps can run in automatic or manual mode. In Remote/Manual mode the operator starts the pump from the HMI. In Remote/Auto mode the WTP-PLC starts the pumps based on the GST level. Currently 4 adjustable level set-points (steps) are set on the PLC for Lead/Lag pump operation.

H. The existing GST level set-points will be modified operation of the existing and new pumps to increase the plant treatment capacity, the following values are by default but they will be adjusted by the operator at the HMI.

1. GST Hi Level Pump Stop
2. Lead Pump Start – 29 ft
3. Lag 1 Pump Start – 27 ft
4. Lag 2 Pump Start – 26.5 ft
5. Lag 3 Pump Start – 26 ft
6. Lag 4 Pump Start – 25.5 ft  
7. Lag 5 Pump Start – 25 ft  
8. Lag 6 Pump Start – 24.5 ft  
9. Low Level  

I. The pumps will be controlled as follows:

1. When the GST level drops below the Lead Well Pump Start set-point and after an adjustable time delay the WTP-PLC starts the Lead Well Pump. If the Lead wells are variable speed motors, the WTP-PLC will automatically increases and decreases the motor speed to reach the GST level set-point. If the Lead well is at maximum speed, and the GST level drops to the Lag 1 Pump Start level set-point and after an adjustable time delay, the WTP-PLC will start the Lag 1 Well Pump. If the Lag 1 well is a variable speed motor, the WTP-PLC will automatically set the pump speed to the same speed and increase or decrease the motor speed to meet the GST level set-point. If the GST level continually drops to the Lag 2 thru Lag 6 Start level set-points and after the associated time delays, the WTP-PLC successively starts Lag pumps and varies the motor speeds, if applicable, based on the type of motor (constant or variable speed) to meet the GST Pump Set-points.

2. If the GST level drops below the Low Level Alarm set-point and after a time delays with all pump in full speed, and alarm will be activated at the HMI.

3. If the Lead and lags 1 thru 6 pumps are running and the GST level increases to the GST level set-point the WTP-PLC will decreases the pumps speeds to its minimum speed. If the GST level is above the GST level set-point, the pumps are in the minimum speed (if applicable) and after a time delay, the WTP-PLC will shutdown the Lag 6 pump. As the GST level reaches the GST level set-point and the pumps are in their minimum speed and after a time delay the WTP-PLC will shutdown the latest lag pump.

4. The WTP-PLC controls the well pumps speed, if applicable, inversely proportional to the GST level set-points.

5. If the WTP-PLC shutdown all the lag pumps and the GST level increase to the GST level set-point, the WTP-PLC will decreased the Lead Pump speed to the minimum speed and the Lead pump continuously run to a minimum speed until the GST level reach the Hi Level Pump Stop set-point. After a adjustable time delay the WTP-PLC will shutdown the Lead Pump.

6. If the GST level reaches above the High Level Alarm set-point and after a time delays, a High Level alarm will be activated at the HMI. If the GST level reaches the High Alarm float switch a High-High Level alarm will be activated at the HMI.

J. The well pump will shutdown if any of the following conditions occurs:

1. If the Level at the Well pumps drops to the Low Level Set-point the associated Well-PLC automatically shutdown the well pumps independent of the level in the GST, the Well-PLC activates an Fail Alarm, and the WTP-PLC takes the well out of sequence and starts one of the lag well pumps. The new wells shall operate in the same way.

2. If the Clearwell reaches the High level set-point and after an adjustable time delay, the WTP-PLC will shutdown the Well Pumps.

3. If the GST level reaches the High level Pump Stop set-point and after an adjustable time delay, the WTP-PLC will shutdown the Well Pumps.
K. Similar to the existing operation, the following actions will be performed by the operator through the HMI:

1. Enter the PUMP MATRIX CONFIGURATION.
2. Enter the GSL LEAD/LAGS LEVEL Set-points.
3. Enter the HIGH and LOW LEVEL ALARM Set-points
4. Enter the MINIMUM and MAXIMUM MOTOR SPEEDs.
5. Enter the PUMP START and STOP Adjustable TIME DELAYS
6. Select REMOTE/AUTO or REMOTE/MANUAL control mode for the well pumps.
7. Enter time delays for pump start/stop after the Minimal/Maximum pump speed is reached.
8. Select the LEAD/LAGS operation mode for well pumps through the 8x8 Well Pump Matrix.
9. Enter the LOW WELL LEVEL - PUMP SHUT DOWN SET-POINT at each well.
10. START/STOP the well pumps in REMOTE/MANUAL control mode.

2.05 INFLUENT FLOW AND FLOW CONTROL VALVES

A. New flow control valves will be installed upstream of new Aerators 3 and 4. The existing and new flow control valves will operate in Manual control mode. The Operator shall set the % of open position of each valve.

B. The WTP-PLC will modulate each flow control valve to meet the % of flow influent set-point at each aerator.

C. The following actions will be performed by the operator through the workstation:
   1. Enter the PLANT INFLUENT FLOW SET-POINT.
   2. Enter the PERCENTAGE OF PLANT INFLUENT FLOW ON EACH AERATOR.
   3. Enter the PLANT MINIMUM INFLUENT FLOW Set-point

2.06 CLARIFIER RAPID MIXER/FLOCCULATOR

A. Existing rapid mix feeds existing Clarifiers 1 and 2. A new Vertical flocculator with a VFD will be provided to feed the New Clarifier 3 through new Aerators 3 and 4.

B. In AUTOMATIC control mode, the rapid mixer and the flocculator will be controlled by the PLC to operate continuously while the influent flow is greater than the PLANT MINIMUM INFLUENT FLOW Set-point.

C. The flocculator Variable Frequency Drive (VFD) will allow operational flexibility to adjust the mixing energy to suit the water being treated. The flocculator speed will be varied as required by the process. The flocculator manufacturer will provide the motor speed setting “Tip Speed” to meet the detection times required by the process. The operator will select at the HMI the speed, from the pre-set ones, in which the flocculator will run.

D. The flocculator manufacturer will provide the motor speed setting to meet the G value and the detection times.

E. The following actions will be performed by the operator through the HMI for new flocculator and existing Rapid Mixer:
   1. Select MANUAL/AUTOMATIC control modes for the rapid mixer and flocculator.
   2. Select pre-configure Flocculator Speed.
3. START/STOP the Rapid Mix / Flocculator in MANUAL control mode. In Manual mode, the Operator will select the pre-configure speed for flocculator operation.

2.07 CHEMICAL SYSTEM

A. Chemical injection on Pre-treatment process is based on a RATIO of the measured influent flow. The influent flow is measured at the plant entry through a venturi flow meter located in the lime room.

B. Chemical injection on Post-treatment process is based on a RATIO of the measured effluent flow. The effluent flow is measured downstream of the clearwell through a venturi flow meter located in the metering vault.

C. At the HMI, the operator enters the Low Influent and Effluent Flow set points for chemical injections. If the influent or effluent flow drops below these set-points the WTP-PLC will shutdown the Pre and Post-treatment chemical systems.

D. Chemical Analyzer

The existing Rapid Mixer pH and chlorine residual analyzers will remain. New pH and chlorine residual analyzers will be installed at the flocculator and a new chlorine residual analyzer will be provided at the Effluent flow. Similar as the current configuration, sample lines will be routed from the measuring point to the electrical room where the new transmitters will be installed. The flocculator pH and chlorine residual measurements will be used for lime and Sodium Hypochlorite feed rates respectively. The Effluent flow chlorine residual measurement will be used for Effluent sodium hypochlorite feed rate.

E. Sodium Hypochlorite Feed System

1. A new Sodium Hypochlorite storage tank will be installed to meet the new requirements of the plant expansion. The existing pre-treatment injection point, downstream of the Aerator 1 and 2, will remain and a new injection point will be provided downstream of the new Aerators 3 and 4.

2. In AUTOMATIC control mode, the Chlorine feed rate will be controlled based on the plant influent flow and chlorine residual, utilizing the following equation:

\[ \text{Chlorine Feed Rate} = \left( \text{Plant Influent Flow} \times \text{Ratio SET-POINT} \right) + \left( \text{Chlorine Residual Error} \times \text{Bias SET-POINT} \right) \]

3. The WTP-PLC shall shutdown the Sodium Hypochlorite system if the influent flow is below the LOW INFLUENT FLOW set-point.

4. No additional modification will be required in existing Sodium Hypochlorite system. The exiting 4 metering pumps will remain, 2 for the Pre and 2 for the Post-treatment processes.

5. The existing Pre-Chlorination and Post Chlorination Run commands and Feed rates I/O signals from the WTP PLC to the pump control panel will remain.

6. The exiting storage tank – day tank transfer process will remain with the addition of the new storage tank. Currently the Sodium Hypochlorite tank transfer is performed by the operator manually at the HMI. The operator manually starts/stops the transfer pump and open/close the transfer valve. If the day tank high level is reached the WTP-PLC automatically stop the transfer pump.

7. The following actions will be performed by the operator through the HMI for new rapid mix/flocculator and existing rapid mixer:

a. Select MANUAL/AUTOMATIC control mode for the chlorine feed system.

b. Enter the PRE-CHLORINATION SODIUM HYPOCHLORITE FEED RATE RATIO SET –POINT.
c. Enter the HYPOCHLORITE RESIDUAL BIAS SET-POINT for when the chlorine feed system is in AUTOMATIC control mode.

d. Enter the POST-CHLORINATION SODIUM HYPOCHLORITE FEED RATE RATIO SET-POINT.

e. Select the Pre and Post-treatment metering LEAD/LAG pumps.

f. START/STOP the Pre-Chlorination Hypochlorite Pump when the chlorine feed system is in MANUAL control mode.

g. START/STOP the Post-Chlorination Hypochlorite Pump when the chlorine feed system is in MANUAL control mode.

h. Enter the PRE-CHLORINATION HYPOCHLORITE FEED RATE for when the chlorine feed system is in MANUAL control mode.

i. Enter the POST-CHLORINATION HYPOCHLORITE FEED RATE for when the chlorine feed system is in MANUAL control mode.

F. Lime Feed System

1. The existing Lime System will be modified for a New High-Density Lime System which will be controlled through its own PLC, standalone PLC. The Lime PLC will communicate through the WTP-PLC via Ethernet network Fiber Optic cable.

2. The two lime trains will operate in a LEAD/Standby configuration.

3. The existing pre-treatment lime injection point, downstream of the Aerators 1 and 2, will remain and a new injection point will be provided downstream of the new Aerators 3 and 4.

4. The Lime System will operate in Manual or Automatic mode. In Manual mode the Operator will enter the Lime feeder rate which will be independent of the plant influent flow. In Automatic mode the PLC will automatically set the lime feeder rate based on the plant influent flow and the pH measurement, utilizing the following equation:

\[ \text{Lime Feed Rate} = (\text{Plant Influent Flow} \times \text{Ratio SET-POINT}) + (\text{pH error} \times \text{Bias SET-POINT}) \]

5. If the Lead train fail the Standby train will automatically start.

6. The currently lime fill process will remain. The operator performs the silos fill process locally at the lime fill station.

7. The lime system will operate the Lead and Lag trains as required to meet the desired lime feeder rate at each injection point.

8. The lime PLC shall allow any train to be set by the operator as a Lead or Lag. If the Lead train is running and a fail occurs, the lime PLC shall automatically set the lag train as a lead and the failed train will be set out of service until the fail condition is cleared.

9. The Lime-PLC will monitoring and controls the operation of the lime system. The operator shall manually open and close the valves at the metering pump discharge based on the metering pump assigned for each feeding point. Then, the operator shall select at the HMI which metering pump is assigned to each feed point.

10. The WTP-PLC shall shutdown the lime system if the influent flow is below the LOW INFLUENT FLOW set-point.
11. Coordination will be required between the Program Engineer and the Lime System Manufacturer for Data to be transferred between WTP-PLC and Lime PLC.

12. The following actions will be performed by the operator through the HMI for Lime System Operation:
   a. Select MANUAL/AUTOMATIC control mode for the lime feed system.
   b. Select the LEAD and LAG LIME TRAIN.
   c. Select the LIME FEEDER RATE TO LAG TRAIN START.
   d. Select the LIME FEEDER RATE TO LAG TRAIN STOP.
   e. Enter the LOW INFLUENT FLOW-LIME FEEDER SHUT DOWN SET-POINT.
   f. Enter the LIME FEED RATE RATIO SET-POINT for when the lime feed system is in AUTOMATIC control mode.
   g. Enter the pH BIAS SET-POINT for when the lime feed system is in AUTOMATIC control mode.
   h. START/STOP the lime feeder when the lime feed system is in MANUAL control mode. (TYP.)
   i. Enter the LIME FEED RATE for when the lime feed system is in MANUAL control mode.
   j. Select the METERING PUMP to EACH FEEDING POINT.

G. Fluoride Feed System

1. The existing Fluoride feed system will remain.

2. In AUTOMATIC control mode, the fluoride feed rate will be controlled based on the plant effluent flow, utilizing the following equation:

   Fluoride Feed Rate = (Plant Effluent Flow * Ratio SET-POINT)

3. The operator shall select the Lead and standby pump.

4. The fluoride metering pump will shut down when the plant effluent flow falls below the LOW PLANT EFFLUENT FLOW SET-POINT.

5. The following actions will be performed by the operator through the HMI for Fluoride System Operation:
   a. Select MANUAL/AUTOMATIC control mode for the fluoride feed system.
   b. Enter the LOW EFFLUENT FLOW - FLUORIDE METERING PUMP SHUT DOWN SET-POINT.
   c. Enter the FLUORIDE FEED RATE RATIO SET-POINT for when the fluoride feed system is in AUTOMATIC control mode.
   d. START/STOP the fluoride metering pump when the fluoride feed system is in MANUAL control mode.
   e. Enter the FLUORIDE FEED RATE for when the fluoride feed is in MANUAL control mode system.
   f. Select the LEAD and STANDBY FLUORIDE PUMP.

H. Polymer Feed System
1. The existing Polymer system will remain and three new Polymer activations unit will be provided.

2. The existing pre-treatment Polymer injection point, located downstream of Aerators 1 and 2, will remain. Two new injection points will be provided, one at the pre-treatment process, located downstream of the Aerators 3 and 4 and the other at the Residual Clarifier.

3. In AUTOMATIC control mode, the polymer feed rate will be controlled based on the plant influent flow, utilizing the following equation:

   Pre-treatment injection point:
   Polymer Feed Rate = (Plant influent Flow * Ratio SET-POINT)

   Post-treatment injection point:
   Polymer Feed Rate = (Recycle Effluent Flow * Ratio SET-POINT)

4. The polymer metering pump will shutdown when the plant influent flow falls below the LOW PLANT INFLUENT FLOW SET-POINT.

5. The Polymer system will operate in Manual/Automatic operation mode. In Manual mode the operator will enter the Polymer Rate to be supplied to the System which will be independent of the Plant Influent Flow. In Automatic mode, the WTP-PLC will set the polymer feed rate at each injection point as indicated in the equation above.

6. The polymer pre-treatment injection point

7. The operator shall manually open and close the polymer discharge valves as required based on the metering pump assigned to each injection point. Polymer unit can be assigned to each injection point as follows:

   a. Existing Polymer Unit 1 – Existing pre-treatment feed point.
   b. New Polymer Unit 2 – Existing or new pre-treatment feed points.
   c. New Polymer Unit 3 – New pre-treatment feed point or new residual feed point.
   d. New Polymer Unit 4 – New residual feed point.

8. The operator shall indicated at the HMI which unit is assigned to each injection point, in that way the WTP-PLC will use the associated flow measure (influent or recycle) to determine the injection rate.

9. The following actions will be performed by the operator through the HMI for Polymer System Operation:

   a. Select the Polymer units assigned to each injection point.
   b. Select MANUAL/AUTOMATIC control mode for the polymer feed system.
   c. Enter the LOW INFLUENT FLOW-POLYMER METERING PUMP SHUT DOWN SET-POINT.
   d. Enter the POLYMER FEED RATE RATIO SET-POINT at the Aerator injection point for when the polymer feed system is in AUTOMATIC control mode.
   e. Enter the POLYMER FEED RATE RATIO SET-POINT at each injection point:
      (1) Pre-treatment injection points
      (2) Recycle injection point
f. START/STOP the polymer metering pump when the polymer feed system is in MANUAL control mode.

2.08 CLARIFIER

A. A new Clarifier system, similar to the existing one, will be provided to increase the plant capacity to 8 mgd.

B. The new clarifier will consist of a flocculator basin, a vacuum chamber and a superpulsator clarifier.

C. Chemical will be added at the new Aerators 3 and 4 discharges upstream of the flocculator basin. The water will flow through the weir to the vacuum chamber and to the new clarifier.

D. The Blowdown system will have a standalone PLC (BD-PLC) which will monitor and controls the clarifier operation and its associated equipment (sludge valves, vacuum pumps, pressure switches, etc).

E. The Blowdown can operate in a Manual/Auto operation modes. In Manual mode the operator manually controls the Blowdown process from the HMI. In Auto mode the BD-PLC controls the blowdown process starting the vacuum pumps when loss of vacuum is detected.

F. A Local Control Station (LCS) will be provided at the Vacuum Room for local operation of the new vacuum pumps.

G. The new clarifier will be monitored and controlled from its own Blowdown PLC (BD-PLC). The existing clarifiers 1 and 2 will be modified to provide a new Blowdown Control Panel with its associated BD-PLC and a LCS. Each BD PLC will communicate with the WTP-PLC via Fiber Optic Cable Ethernet network.

2.09 FILTERS

A. A new Greenleaf Filter system, similar to the existing one, will be provided to increase the total filtration capacity of the plant to 8 mgd.

B. Similar to the existing filter, the new filter consists of 4 gravity filter cells. The four cells of both filters could be in operation at the same time. But only one cell of each filter can be backwashed at the same time.

C. The filter PLC will have an standalone PLC (Filter-PLC) monitoring and controls the filter and backwash process with their associated equipment (Air scour, Vacuum Pumps, Blowers, Solenoid Valves, etc)

D. The filters can operate in Manual/Semi/Auto model. In Manual mode the operator controls the system manually from the HMI. In Semi Mode the WTP-PLC controls the Filter operation, but the backwash is activated manually by the operator at the HMI. In Auto mode the WTP-PLC controls the entire filter system, the filter and backwash processes. In Auto mode the Filter PLC will determine the cell to be backwashed based on time (0-24 hours).

E. The filter cell is backwashed from its associated clearwell. The exiting filter cells are backwashed from the existing clearwell, consequently the new filter cells will be backwashed from the new clearwell.

F. Only one cell of any filter can be backwashed at a time.

G. Two existing air scours will be used to backwash the cell. The air scours operate in a Lead/Standby operation mode. Each filter PLC shall communicate each to follow the sequence of the filter cell to be backwashed. Each filter PLC will control the air scour and associated air valves for bachwashing.

H. The filter backwash will be allowed in any of the following conditions do not occur:
1. High level condition in the Transfer Tank.

2. Plant influent flow is above the permissible B/W influent flow.

I. A Local Control Station (LCS) will be provided at the new filter room for local operation of the filter.

J. The new filter will be monitoring and controlling from its own PLC. The existing filter will be modified to provide a new filter Control Panel with its associated PLC and a LCS. Each filter PLC will communicate with the WTP-PLC via Fiber Optic Cable Ethernet network.

K. The following actions will be performed by the operator through the SUN workstation for the Filter Systems Operation:

1. Select MANUAL/AUTOMATIC control mode for the filters.

2. Enter the PERMISSIVE B/W INFLUENT FLOW (ENABLE BACKWASH)

3. Enter the BACKWASH RUN CYCLE time period, the parameters shown below are the current setting in the existing filter, values shall be verified with the Filter Manufacturer:
   a. Filter drain time (0-68.25 min): 1 min
   b. Filter air time (0-68.25 min): 1 min
   c. Air/wash time (0-68.25 min): 18 min
   d. Water wash time (0-68.25 min): 10 min
   e. Time to start B/W (0-24 hours): 5 hours

4. Enter the FILTER DIFFERENTIAL PRESSURE SET-POINT. (START BACKWASH), when the Filter is in Automatic mode.

5. INITIATE FILTER BACKWASH in the MANUAL control mode.

2.10 CLEARWELL PUMPS

A. The existing 3 clearwell pumps operate in a Lead/Lag/Standby configuration. The operator selects the lead/lag/standby pumps through the 3x3 C/W pumps matrix at the HMI.

B. A new clearwell with 3 pumps will be provided downstream of the new filter. These pumps shall operate similar to the existing one. A new matrix 3x3 shall be configured for the new C/W pumps.

C. Similar to the existing clearwell pumps, the new clearwell pumps will run in Manual/Automatic operation mode. In Manual mode, the operator will start/stop the clearwell pumps and set the speed as desired from the HMI. In automatic mode the WTP-PLC will start/stop the Clearwell pumps and set the motor speed based on the Clearwell level.

D. The following parameters shall be set for new C/W pump operation:

1. GST Hi Level to Stop C/W Pumps

2. C/W Level overflow Set-point (0-14 ft): 14 ft

3. C/W Level Set-point (0-14 ft): 8 ft.

4. Low C/W level stop pumps (0-14 ft): 3.5 ft

5. Time delay for C/W pump start/stop (0-4095 sec): 280 sec
E. The pumps will be controlled as follows:

1. When the C/W level drops below the C/W Level Set-point and after an adjustable
time delay the WTP-PLC starts the Lead Pump. The WTP-PLC will automatically
increases and decreases the motor speed to maintain the C/W level set-point. If
the C/W level is below the C/W Level Set-point, the Lead pump is at maximum
speed and after a time delay, the WTP-PLC will start the Lag Pump. Both pumps,
Lead and Lag, will run at the same speed The WTP-PLC will increase or
decrease the pumps speed as required to maintain the C/W level set-point.

2. If the C/W level continually drops to the Low C/W level stop pumps set-point and
after a time delays, the WTP-PLC will shutdown the C/W pumps. A C/W low level
alarm will be displayed at the HMI. The clearwell pumps will be locked out until
the alarm is cleared.

3. If the Lead and lag pumps are running and the C/W level increases to the C/W
level set-point the WTP-PLC will decrease the pumps speeds until their speeds
drop to the Minimal speed, after an adjustable time delay, the WTP-PLC will turn
off Lag pump. If the C/W level is above the C/W Level set-point, the pumps are
in the minimum speed and after a time delay, the WTP-PLC will shutdown the
Lag pump. Then the WTP-PLC will adjust the speed of the pump that remains
running. If C/W level increases to the C/W level set-point the WTP-PLC will
decrease the pump speed until its speed drop to the Minimal speed, after an
adjustable time delay, the WTP-PLC will turn off the Lead pump.

4. The WTP-PLC controls the well pumps speed inversely proportional to the C/W
level set-points.

5. If the GST level is above the GST Hi Level Pump Stop set-point, and after a time
delay, the WTP-PLC shutdowns the C/W pumps independently of the C/W level.

6. If the Plant influent flow is lower than the sum of effluent and recycle flows, only
one C/W pump shall be running. In normal condition, for existing and new C/W
pump operation, the Plant influent flow shall be greater than the sum of effluent
and recycle flows.

F. If the operator sets a clearwell out of service, the PLC will automatically set the
associated pumps out of service.

G. The new and existing clearwell pumps will operate in a LEAD/LAG/Standby configuration.
The operator will select the Lead and Lag pumps for each clearwell though the following
matrixs:

<table>
<thead>
<tr>
<th>Clearwell 1</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>CWP 1</td>
<td>CWP 2</td>
</tr>
<tr>
<td></td>
<td>1750gpm</td>
<td>1750gpm</td>
</tr>
<tr>
<td>Lead</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lag</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Standby</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Clearwell 2</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>CWP 4</td>
<td>CWP 5</td>
</tr>
<tr>
<td></td>
<td>1750gpm</td>
<td>1750gpm</td>
</tr>
<tr>
<td>Lead</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
VFD at all Clearwell pumps

H. Water for the associated filter clearwell will be used for backwashing. The operator will ensure that the manual valves between the clearwell and the filter cells are set as required for backwashing.

I. The following actions will be performed by the operator through the HMI for Clearwell System Operation:

1. Select the CLEARWELL PUMPS LEAD/LAG/STANDBY OPERATION MODE for each clarwell. Enter the PUMP CONFIGURATION MATRIX (3x3).
2. Select MANUAL/AUTOMATIC control mode for the clearwell pumps.
3. Enter the C/W LEVEL OVERFLOW SET-POINT.
4. Enter the C/W LEVEL SET-POINT.
5. Enter the LOW CLEARWELL LEVEL - PUMP SHUT DOWN SET-POINT. Enter time delays for pump start/stop after the Minimal/Maximum pump speed is reached.
6. Enter the MINIMUM and MAXIMUM C/W PUMP SPEEDS.
7. START/STOP the clearwell pumps when the pumps are in MANUAL operation mode.

2.11 TRANSFER/SLUDGE PUMPS

A. The existing Transfer Pumps and Sludge pumps will remain.
B. The existing pumps operate as independent systems. Pump Status is monitored by the WTP PLC.
C. Transfer Tank Hi Level interlocks the Filter B/W process thru the WTP-PLC.
D. Pumps are automatically alternated thru the Local Control Panel.
E. A submersible mixer will be installed in the existing Transfer Tank. The mixer will operate continuously. A Local Control Station will be located at the Transfer Tank for mixer operation.

2.12 RECYCLE AND RESIDUAL PUMPS

A. New Recycle and Residual pump will be independent system. The pumps will be controlled based on the Recycle and Residual level, respectively.
B. Pumps will be provided as a package with its Local Control Panel. Pumps status and alarms, High Level alarm and continuous level measurement will be connected to the WTP-PLC for monitoring.
C. Pumps are automatically alternated thru the Local Control Panel.
D. The operator will set at the HMI the level set-point for level control of each pumping station.

2.13 CLARIFIER DRIVE
A. Existing Solids Holding Tank will be modified to a Residuals Clarifier by providing a new drive. The drives will continuously operate. Drive status, and fail signal will be connected to the WTP-PLC for monitoring.

2.14 EFFLUENT FLOW
A. Existing flow meter will remain.
B. A minimum effluent flow set-point shall be set by the Operator at the HMI for Post-treatment chemical system shutdown.
C. The following actions will be performed by the operator through the HMI:
   1. Enter the PLANT MINIMUM EFFLUENT FLOW Set-point.

2.15 BOOSTER PUMPS
A. A new PLC will be provided at the existing Booster Pumping Station for system monitoring and control. The BPS-PLC will communicate with the WTP-PLC via Ethernet network, fiber optic cable.
B. The booster pumps are controlled to maintain a level in the Central Ave Water Storage Tank (WST) and a minimum system pressure based on operator entered set-points. A HMI selector switch allow the operator to choose the control mode (by pressure or by level)
C. The Booster pump station consists of 3 pumps that operate in a Lead/Lag configuration. One VFD is set for Pumps 1 and 2, the operator manually selects which pump is set to the VFD. Pump 3 has its own VFD.
D. The primary control variable will be tank level with override control based on system pressure. In AUTOMATIC control mode, the PLC will control the operation of the booster pumps to start the lead pump when the tank level falls below the TANK LEVEL CONTROL SET-POINT. The speed of the lead pump will be controlled by the PLC such that the speed increases as tank level falls and the speed decreases as tank level rises. The lead pump will stop when the tank level meets or exceeds the TANK LEVEL CONTROL SETPOINT after a time delay.
E. If the lead pump is called to operate at full speed for an adjustable time delay, the lag pump will start. While the lag pump is operating, the speed of the lead pump will be controlled by the BPS-PLC and will vary indirectly proportional to tank level. The lag pump will stop when the tank level meets or exceeds the TANK LEVEL CONTROL SET-POINT.
F. If the system pressure falls below an adjustable system minimum pressure of 60 PSI, the lead pump will start and operate at a speed of an adjustable lead pump speed, independent of the tank level. Booster pump selection is accomplished manually via local controls.
G. The booster pumps will shut down if a low GST level alarm occurs, independent of tank level and system pressure.
H. The following actions will be performed by the operator through the HMI for the Booster Pump Operation:
   1. Select MANUAL/AUTOMATIC control mode for the booster pumps.
   2. Enter the following GST set-points:
      a. HIGH GST LEVEL STOP PUMP SET-POINT
      b. LOW GST LEVEL-PUMP SHUT DOWN SET-POINT.
   3. Enter the WST Set-points:
a. WST LEVEL CONTROL SET-POINT
b. MAXIMUM SYSTEM PRESSURE SET-POINT, above that the pump cannot run
c. MINIMUM SYSTEM PRESSURE SET-POINT, Pump runs independent of the Central WST level.

4. Enter the MINIMUM and MAXIMUM PUMP SPEEDS.
5. Select the BOOSTER PUMP CONTROL MODE (by CENTRAL WST LEVEL or by SYSTEM PRESSURE)
6. START/STOP the individual booster pumps in MANUAL control mode.
7. Enter the SPEED SETTING for the lead pump in MANUAL control mode.

2.16 HUMAN MACHINE INTERFACE

The following signals are/will be displayed for monitoring and alarming.
Signals calculated by the PLC are identify as $^\text{calc}$ in the tables below.

A. WELL PUMP

<table>
<thead>
<tr>
<th>Type</th>
<th>Signal</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Monitoring</td>
<td>Well No. X. Level, 0-XXX feet</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Well Pump No. X. Run Status (On/Off)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Well Pump No. X. Speed Indication $^*$</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Well Pump No. X. Speed Control $^*$</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Well Pump No. X. Run Time, 0-XXX Hours $^\text{calc}$</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Well Pump No. X. Required Status (Required/Not) $^\text{calc}$</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Well No. X. Discharge Flow, 0-XXX gpm</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Well No. X. Discharge Total Flow, 0-XXX gallons $^\text{calc}$</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Well Pump No. X. Discharge Pressure, 0-XXX psig.</td>
<td></td>
</tr>
<tr>
<td>Alarm</td>
<td>Well No. X. Level Low</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Well Pump No. X. High Discharge Pressure</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Well Pump No. PLC Failure</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Well Pump No. Communication Fail $^\text{calc}$</td>
<td></td>
</tr>
</tbody>
</table>

* Only for Variable Speed Motor.

B. INFLUENT FLOW

<table>
<thead>
<tr>
<th>Type</th>
<th>Signal</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Monitoring</td>
<td>Plant Influent Flow, 0-XXX gpm</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Aerator 3 and 4 Influent Flow, 0-XXX gpm</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Aerator 1 and 2 Influent Flow, 0-XXX gpm $^\text{calc}$</td>
<td></td>
</tr>
<tr>
<td>Type Signal</td>
<td>Description</td>
<td></td>
</tr>
<tr>
<td>-------------</td>
<td>-------------</td>
<td></td>
</tr>
<tr>
<td>Monitoring</td>
<td>Rapid Mixer Status (On/Off)</td>
<td></td>
</tr>
</tbody>
</table>
|             | Rapid Mixer Required Status (Required/Not)  
|             | Rapid Mixer Run Time, 0-XXX Hours   |
|             | Flocculator Status (On/Off) |
|             | Flocculator Speed Ind |
|             | Flocculator Run Time, 0-XXX Hours |
| Alarm       | Rapid Mixer Fail   |
|             | Flocculator Fail |

**C. RAPID MIXER AND FLOCCULATOR**

<table>
<thead>
<tr>
<th>Type Signal</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Monitoring</td>
<td>Monitoring Vacuum Chamber Blower No. X. Run Status (On/Off).</td>
</tr>
<tr>
<td></td>
<td>Vacuum Chamber Blower No. X. Run Time, 0-XXX Hours</td>
</tr>
</tbody>
</table>

**D. VACUUM CHAMBERS**

<table>
<thead>
<tr>
<th>Type Signal</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Monitoring</td>
<td>Rapid Mixer pH Analyzer</td>
</tr>
<tr>
<td></td>
<td>Rapid Mixer Cl Residual Analyzer</td>
</tr>
<tr>
<td></td>
<td>Flocculator pH Analyzer</td>
</tr>
<tr>
<td></td>
<td>Flocculator Cl Residual Analyzer</td>
</tr>
<tr>
<td></td>
<td>Effluent Cl Residual Analyzer</td>
</tr>
<tr>
<td>Alarm</td>
<td>Rapid Mixer High and Low pH</td>
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<tr>
<td></td>
<td>Rapid Mixer High and Low Cl Residual</td>
</tr>
<tr>
<td></td>
<td>Flocculator High and Low pH</td>
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<tr>
<td></td>
<td>Flocculator High and Low Cl Residual</td>
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<tr>
<td></td>
<td>Effluent High and Low Cl Residual</td>
</tr>
</tbody>
</table>

**E. CHEMICAL ANALYZER**

<table>
<thead>
<tr>
<th>Type Signal</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Monitoring</td>
<td>Day Tank 1. Level, 0-XXX Feet</td>
</tr>
</tbody>
</table>

**F. SODIUM HYPOCHLORITE FEED**
<table>
<thead>
<tr>
<th>Day Tank 2. Level, 0-XXX Feet</th>
</tr>
</thead>
<tbody>
<tr>
<td>Storage Tank 1. Level, 0-XXX Feet</td>
</tr>
<tr>
<td>Storage Tank 2. Level, 0-XXX Feet</td>
</tr>
<tr>
<td>Transfer Pump. Status (On/Off).</td>
</tr>
<tr>
<td>Transfer Pump. Fail</td>
</tr>
<tr>
<td>Transfer Pump. Run Time, 0-XXX Hours</td>
</tr>
<tr>
<td>Pre-chlorination Meter Pump 1. Status (On/Off).</td>
</tr>
<tr>
<td>Pre-chlorination Meter Pump 1. Feedrate</td>
</tr>
<tr>
<td>Pre-chlorination Meter Pump 1. Run Time, 0-XXX Hours</td>
</tr>
<tr>
<td>Pre-chlorination Meter Pump 2. Status (On/Off).</td>
</tr>
<tr>
<td>Pre-chlorination Meter Pump 2. Feedrate</td>
</tr>
<tr>
<td>Pre-chlorination Meter Pump 2. Run Time, 0-XXX Hours</td>
</tr>
<tr>
<td>Post-chlorination Meter Pump 1. Status (On/Off).</td>
</tr>
<tr>
<td>Post-chlorination Meter Pump 1. Feedrate</td>
</tr>
<tr>
<td>Post-chlorination Meter Pump 1. Run Time, 0-XXX Hours</td>
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<td>Post-chlorination Meter Pump 2. Status (On/Off).</td>
</tr>
<tr>
<td>Post-chlorination Meter Pump 2. Feedrate</td>
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**Alarm**

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<td>Storage Tank 1. Level High</td>
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<tr>
<td>Storage Tank 1. Level Low</td>
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<tr>
<td>Storage Tank 2. Level High</td>
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<tr>
<td>Storage Tank 2. Level Low</td>
</tr>
<tr>
<td>Transfer Pump. Fail</td>
</tr>
<tr>
<td>Type</td>
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## H. FLUORIDE FEED

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<tr>
<td>Monitoring</td>
<td>Fluoride Tank No. 1. Level, 0-XX Feet</td>
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<td>Monitoring</td>
<td>Fluoride Tank No. 2. Level, 0-XX Feet</td>
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<tr>
<td>Monitoring</td>
<td>Fluoride Tank No. 1. Total Usage, 0-XX gallons</td>
</tr>
<tr>
<td>Monitoring</td>
<td>Fluoride Tank No. 2. Total Usage, 0-XX gallons</td>
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<tr>
<td>Monitoring</td>
<td>Fluoride Metering Pump No. 1. Required</td>
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<tr>
<td>Monitoring</td>
<td>Fluoride Metering Pump No. 1. Run Time, 0-XX Hours</td>
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<tr>
<td>Monitoring</td>
<td>Fluoride Metering Pump No. 2. Status (On/Off).</td>
</tr>
<tr>
<td>Monitoring</td>
<td>Fluoride Metering Pump No. 2. Required</td>
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<tr>
<td>Monitoring</td>
<td>Fluoride Metering Pump No. 2. Run Time, 0-XX Hours</td>
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<tr>
<td>Alarm</td>
<td>Fluoride Storage Tank No. 1. Refill</td>
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<tr>
<td>Alarm</td>
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## I. POLYMER FEED

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<tr>
<td>Monitoring</td>
<td>Polymer Unit 1. Status (On/Off)</td>
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<tr>
<td>Monitoring</td>
<td>Polymer Unit 1. Speedrate</td>
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<tr>
<td>Monitoring</td>
<td>Polymer Unit 1. Run Time, 0-XXX Hours</td>
</tr>
<tr>
<td>Monitoring</td>
<td>Polymer Unit 2. Status (On/Off)</td>
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<tr>
<td>Monitoring</td>
<td>Polymer Unit 2. Speedrate</td>
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<tr>
<td>Monitoring</td>
<td>Polymer Unit 2. Run Time, 0-XXX Hours</td>
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<tr>
<td>Monitoring</td>
<td>Polymer Unit 3. Status (On/Off)</td>
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<tr>
<td>Monitoring</td>
<td>Polymer Unit 3. Speedrate</td>
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<td>Monitoring</td>
<td>Polymer Unit 3. Run Time, 0-XXX Hours</td>
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<tr>
<td>Monitoring</td>
<td>Polymer Unit 4. Status (On/Off)</td>
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<tr>
<td>Monitoring</td>
<td>Polymer Unit 4. Speedrate</td>
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<tr>
<td>Monitoring</td>
<td>Polymer Unit 4. Run Time, 0-XXX Hours</td>
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<td>Alarm</td>
<td>Polymer Unit 2. Low Flow</td>
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<td>Alarm</td>
<td>Polymer Unit 3. Low Flow</td>
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<td>Alarm</td>
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### J. CLARIFIER

#### 1. Blowdown 1 – Clarifiers 1 and 2

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#### 2. Blowdown 2 Clarifier 3

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<td>Vacuum Pump No. 5. Run Status (On/Off)</td>
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### K. FILTERS

#### 1. Filter 1

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<td>Monitoring</td>
<td>Filter 1 Cell No. 1. Status (NORMAL, BW)</td>
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<td>Filter 1 Cell No. 2. Status (NORMAL, BW)</td>
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<td>Filter 1 Cell No. 3. Status (NORMAL, BW)</td>
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<td>Filter 1 Cell No. 4. Status (NORMAL, BW)</td>
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<tr>
<td></td>
<td>Filter 1 Cell No. 1. Mode (Auto, Semi)</td>
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<td>Filter 1 Cell No. 2. Mode (Auto, Semi)</td>
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<tr>
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<td>Filter 1 Cell No. 3. Mode (Auto, Semi)</td>
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<td>Filter 1 Cell No. 4. Mode (Auto, Semi)</td>
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<td></td>
<td>Filter 1 Cell No. 2. High Level head Loss</td>
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<td>Filter 1 Cell No. 3. High Level head Loss</td>
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<td></td>
<td>Filter 1 Cell No. 4. High Level head Loss</td>
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<tr>
<td></td>
<td>Filter 1 Cell No. 1. Status (On/Off)</td>
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<td></td>
<td>Filter 1 Cell No. 2. Status (On/Off)</td>
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<td>Filter 1 Cell No. 3. Status (On/Off)</td>
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<td>Filter 1 Cell No. 1. Start</td>
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<td>Filter 1 Cell No. 3. Start</td>
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**Alarm**

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<td>Filter 1 Cell No. 3. High Level</td>
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<td>Filter 1 Cell No. 4. High Level</td>
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2. **Filter 2**

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<td>Filter 2 Cell No. 2. Status (NORMAL, BW)</td>
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<td>Filter 2 Cell No. 3. Start</td>
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### Filter 2 Cell No. 4
- **Alarm**
  - Filter 2 Cell No. 1. High Level
  - Filter 2 Cell No. 1. Low Level
  - Filter 2 Cell No. 2. High Level
  - Filter 2 Cell No. 2. Low Level
  - Filter 2 Cell No. 3. High Level
  - Filter 2 Cell No. 3. Low Level
  - Filter 2 Cell No. 4. High Level
  - Filter 2 Cell No. 4. Low Level

### L. CLEARWELL No 1

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<td>Clearwell Pump No. 1. Run Time 0-XXX Hours</td>
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<td>Clearwell Pump No. 2. Run Status (On/Off)</td>
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<td>Clearwell Pump No. 3. Run Status (On/Off)</td>
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<td>Clearwell Pump No. 3. Required Status</td>
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<td>Clearwell Pump No. 3. Run Time 0-XXX Hours</td>
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<td>Plant Effluent Total Flow, 0-XXX gallons</td>
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<td><strong>Alarm</strong></td>
<td>Clearwell No. 1. High Level</td>
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<td>Clearwell No. 1. Low Level</td>
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### M. CLEARWELL No 2

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<td>Clearwell Pump No. 5. Run Time 0-XXX Hours</td>
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<td>Clearwell Pump No. 6. Run Status (On/Off)</td>
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<td>Clearwell Pump No. 6. Run Time 0-XXX Hours</td>
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**Plant Effluent Flow, 0-XXX gpm**

**Plant Effluent Total Flow, 0-XXX gallons**

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<td>Clearwell No. 2. Overflow</td>
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<td>Clearwell No. 2. Low Level</td>
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<td>Clearwell Pump No. 4. Fail</td>
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<tr>
<td>Clearwell Pump No. 5. Fail</td>
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<td>Clearwell Pump No. 6. Fail</td>
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### N. BLEND TANK

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<tr>
<td>Monitoring</td>
<td>Transfer Tank Level, 0-XXX Feet</td>
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<tr>
<td>Transfer Pump No. 1. Run Status (On/Off)</td>
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<td>Transfer Tank Level, 0-XXX Feet</td>
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<td>Transfer Pump No. 2. Run Status (On/Off)</td>
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<td>Transfer Pump No. 2. Run Time, 0-XXX Hours</td>
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<td>Submersible Mixer. Run Status (On/Off)</td>
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<td>Submersible Mixer. Run Time, 0-XXX Hours</td>
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<td>Transfer Pumps Discharge Flow, 0-XXX gpm.</td>
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<th>Alarm</th>
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<tbody>
<tr>
<td>Transfer Tank High Level</td>
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<td>Submersible Mixer Status. Shutdown</td>
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### O. SLUDGE PUMP

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<td>Sludge Pump No. 2. Run Status (On/Off)</td>
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<tr>
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<tr>
<td>Sludge Flow, 0-XXX gpm.</td>
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<tr>
<td>Sludge Total Flow, 0-XXX gallons.</td>
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### P. RESIDUAL PUMP

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<td>Residual Pump No. 1. Run Status (On/Off)</td>
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<td>Residual Pump No. 1. Bypass Active</td>
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<td></td>
<td>Residual Pump No. 1. Run Time, 0-XXX Hours (^{calc})</td>
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<td>Residual Pump No. 2. Run Status (On/Off)</td>
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<td>Residual Pump No. 2. Bypass Active</td>
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<td></td>
<td>Residual Pump No. 2. Run Time, 0-XXX Hours (^{calc})</td>
<td></td>
</tr>
<tr>
<td>Alarm</td>
<td>Residual Station High Level</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Residual Pump No. 1. High Temperature</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Residual Pump No. 1. Drive failure</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Residual Pump No. 2. High Temperature</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Residual Pump No. 2. Drive failure</td>
<td></td>
</tr>
</tbody>
</table>

### Q. RESIDUALS CLARIFIER

<table>
<thead>
<tr>
<th>Type</th>
<th>Signal</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Monitoring</td>
<td>Monitoring Recycle Level, 0-XXX Feet.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Drive. Run Status (On/Off)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Drive. Run Time, 0-XXX Hours (^{calc})</td>
<td></td>
</tr>
<tr>
<td>Alarm</td>
<td>Drive warning – 85% torque</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Drive alarm – 100% torque</td>
<td></td>
</tr>
</tbody>
</table>

### R. RECYCLE PUMP

<table>
<thead>
<tr>
<th>Type</th>
<th>Signal</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Monitoring</td>
<td>Monitoring Recycle Level, 0-XXX Feet.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Recycle Pump No. 1. Run Status (On/Off)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Recycle Pump No. 1. Bypass Active</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Recycle Pump No. 1. Run Time, 0-XXX Hours (^{calc})</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Recycle Pump No. 2. Run Status (On/Off)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Recycle Pump No. 2. Bypass Active</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Recycle Pump No. 2. Run Time, 0-XXX Hours (^{calc})</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Recycle Flow, 0-XXX gpm.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Recycle Total Flow, 0-XXX gallons.</td>
<td></td>
</tr>
<tr>
<td>Alarm</td>
<td>Recycle High Level</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Recycle Pump No. 1. High Temperature</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Recycle Pump No. 1. Drive failure</td>
<td></td>
</tr>
</tbody>
</table>
## S. EFFLUENT FLOW

<table>
<thead>
<tr>
<th>Type Signal</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Monitoring</td>
<td>Effluent Flow, 0-XXX gpm</td>
</tr>
<tr>
<td></td>
<td>Effluent Total Flow, 0-XXX gallons&lt;sup&gt;calc&lt;/sup&gt;</td>
</tr>
</tbody>
</table>

## T. BOOSTER PUMPS

<table>
<thead>
<tr>
<th>Type Signal</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Monitoring</td>
<td>GST Level, 0-XX Feet</td>
</tr>
<tr>
<td></td>
<td>Central Tank Level, Ft</td>
</tr>
<tr>
<td></td>
<td>Booster Pump No. 1. Valve open</td>
</tr>
<tr>
<td></td>
<td>Booster Pump No. 1. Run Status (On/Off).</td>
</tr>
<tr>
<td></td>
<td>Booster Pump No. 1. Required</td>
</tr>
<tr>
<td></td>
<td>Booster Pump No. 1. Run Time, 0-XXX Hours&lt;sup&gt;calc&lt;/sup&gt;</td>
</tr>
<tr>
<td></td>
<td>Booster Pump No. 2. Valve Open</td>
</tr>
<tr>
<td></td>
<td>Booster Pump No. 2. Run Status (On/Off).</td>
</tr>
<tr>
<td></td>
<td>Booster Pump No. 2. Required</td>
</tr>
<tr>
<td></td>
<td>Booster Pump No. 2. Run Time, 0-XXX Hours&lt;sup&gt;calc&lt;/sup&gt;</td>
</tr>
<tr>
<td></td>
<td>Booster Pump No. 1 or 2 In VFD</td>
</tr>
<tr>
<td></td>
<td>Booster Pump No. 1 or 2. Speed Ind</td>
</tr>
<tr>
<td></td>
<td>Booster Pump No. 3. Valve Open</td>
</tr>
<tr>
<td></td>
<td>Booster Pump No. 3. Run Status (On/Off).</td>
</tr>
<tr>
<td></td>
<td>Booster Pump No. 3. Speed Ind</td>
</tr>
<tr>
<td></td>
<td>Booster Pump No. 3. Required</td>
</tr>
<tr>
<td></td>
<td>Booster Pump No. 3. Run Time, 0-XXX Hours&lt;sup&gt;calc&lt;/sup&gt;</td>
</tr>
<tr>
<td>Alarm</td>
<td>GST Low Level</td>
</tr>
<tr>
<td></td>
<td>GST Overflow</td>
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<td></td>
<td>Pumping Station Flood</td>
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<tr>
<td></td>
<td>System High Pressure</td>
</tr>
<tr>
<td></td>
<td>System Low Pressure</td>
</tr>
<tr>
<td></td>
<td>BPS Intrusion</td>
</tr>
<tr>
<td>Booster Pump No. 1</td>
<td>Fail</td>
</tr>
<tr>
<td>--------------------</td>
<td>------</td>
</tr>
<tr>
<td>Booster Pump No. 2</td>
<td>Fail</td>
</tr>
<tr>
<td>Booster Pump No. 3</td>
<td>Fail</td>
</tr>
</tbody>
</table>
Customer Relations Requirements

All consultants, contractors, subcontractors, suppliers and etc., are required to assume their part in the County's Customer Oriented Programs. A description of the Department's policy and its action items are as follows:

"The Department of Public Works has a customer oriented philosophy that requires all employees, consultants, contractors, etc., to adhere to the five dimensions of quality service."

The Five Dimensions of Quality Service Are:

1. Reliability: Is what was promised provided dependably and accurately?
   a. Scheduling
   b. Proper notification
   c. Traffic control
   d. Sediment control
   e. Quality of work

2. Assurance: Are the employees knowledgeable and courteous, and can they express trust and confidence?
   a. Citizen interaction - knowledgeable
   b. Concerns remedied

3. Empathy: Are caring and individual attention provided?
   a. Citizen interaction - polite, courteous
   b. Callbacks will be treated as part of the construction effort
4. Responsiveness: Is there a willingness to help customers and provide proper service?

   a. Response to citizen concern within two days. If required work is anticipated to exceed two days, a schedule must be provided indicating when work will be completed.

   b. Additionally, follow-up must be accomplished. Whether the work is complete or not, the follow-up must be done.

5. Tangibles: Are the physical facilities and equipment customer friendly?

   a. Traffic control
   b. Sediment control
   c. Safe driving - includes control of speed of vehicles
   d. Sanitary facilities provided for manpower

As a means of ensuring the contractor's participation, each contractor must provide a customer plan and a team composition responsible for adhering to the "Five Dimensions of Customer Service" given previously. Additionally, the plan and the team composition are to be submitted within fourteen (14) calendar days of NTP or concurrent with the contractor's on-site mobilization. The team leader is required to oversee the entire program and be available to assist in resolution of concerns. The other members of the team will provide courteous and prompt assistance to concerns. Any contractor's employee(s) not performing in accordance with the above will be subject to removal from further participation in the project upon written order from the County representative. Failure to participate or respond as required shall be cause for termination of the contract for non-performance.
CONTRACTOR SECURITY PROGRAM

This appendix describes measures to be taken by the contractor to reduce the risk of vulnerability to Anne Arundel County Department of Public Works (DPW) Utility Operations facilities for each of the Homeland Security Threat Advisory Levels. Utility Operations personnel may take measures based on the Department of Public Works Policy and Procedures Manual that will impact the contractor’s work. Consultants, contractors, subcontractors, suppliers, etc. are required to perform their part in this program.

The following measures shall be implemented based on the security threat level declared by Utility Operations.

Standard Practice & Measures

1. Carry identification while on Utility Operations property. Minimum identification may consist of a printed or hand written business card or paper bearing the hiring company’s name, the individual’s name and the signature of the hiring company foreman, supervisor or other representative.

2. Challenge unknown visitors. Request identification and purpose of visit.

3. Review security procedures with personnel.

4. Report suspicious activity (carrying suitcases / containers, photographing, noting or asking questions about operations, pumping or pipeline operations or security measures) to supervision. Supervision determines whether to contact law enforcement and chain of command.

5. Report unidentified vehicles parked or operated in a suspicious manner on or in Utility Operations facilities, equipment or rights-of-way. Notify supervision of infractions. Supervision determines whether to contact law enforcement and chain of command.

Elevated Threat Advisory Level – No Specific Information on Timing or Location

1. Remind personnel to:
   a. Carry identification while on Utility Operations property. Minimum identification may consist of a printed or hand written business card or paper bearing the hiring company’s name, the individual’s name and the signature of the hiring company foreman, supervisor or other representative.
   b. Challenge unknown visitors.
   c. Request identification and purpose of visit.

2. Cease public tours.
3 If directed by Utility Operations:
   a. Remove vehicles and objects (e.g. dumpsters) parked within 25 yards of specified facilities.
   b. Park vehicles outside facilities. Implement centralized parking and shuttle service.
   c. Report suspicious vehicles or objects to Utility Operations supervision.
   d. Verify the identity of individuals entering specified facilities.
   e. Facility gates and entrances will be locked, except when passing through. Limit access to essential employees and contractors. Verify the identity of individuals entering facilities. Issue visitor badges to visitors.
   f. Inspect buildings, rooms and storage areas not in regular use, daily.
   g. Inspect the interior and exterior of buildings for suspicious activities or packages. Check for signs of tampering or indications of unauthorized entry.

4 Utility Operations may:
   a. Erect barriers to control the direction of traffic flow and parking.
   b. Consult with law enforcement to close public roads and facilities.

**Imminent Threat Advisory Level – Threat at Location Impending or Very Soon**

1 Remind personnel to:
   a. Display identification while on Utility Operations property. Minimum identification may consist of a printed or hand written business card or paper bearing the hiring company’s name, the individual’s name and the signature of the hiring company foreman, supervisor or other representative.
   b. Challenge unknown visitors.
   c. Request identification of anyone not displaying it and ask the purpose of his or her visit.

2 Limit access to facilities and activities to personnel with legitimate and verifiable need to enter.
   a. Cease Public Tours

3 Buildings, rooms, and storage areas will be locked. Inspect baggage, briefcases, and packages brought to the facility.

4 If directed by Utility Operations:
   a. Remove vehicles and objects (e.g. dumpsters) parked within 25 yards of specified facilities. Identify owners of vehicles on Utility Operation property. Have unidentified vehicles inspected by law enforcement personnel and, if appropriate, removed.
   b. Park vehicles outside facilities. Implement centralized parking and shuttle service.
   c. Inspect delivery vehicles and containers entering the facility. Require advance delivery notification and validate credentials of the driver.
   d. Implement daily inspections of specified buildings and grounds.
   e. Take steps to control access to specified facilities.
f. Facility gates and entrances will be locked, except when passing through. Limit access to essential employees and contractors. Verify the identity of individuals entering facilities. Issue visitor badges to visitors.

g. Inspect buildings, rooms and storage areas not in regular use daily.

h. Inspect the interior and exterior of buildings for suspicious activities or packages. Check for signs of tampering or indications of unauthorized entry.

i. Implement mailroom procedures. Have mail and packages sent to a central, secure location and inspected before distribution.

5 Utility Operations may:

   a. Restrict access to specific facilities.
   b. Request closure of public roads and facilities in the vicinity of specified facilities.
   c. Stop work in part or in total.
   d. Erect barriers to control the direction of traffic flow and parking.
   e. Consult with law enforcement to close public roads and facilities.
   f. Post guards.
Revised Geotechnical Engineering Report

Broad Creek Water Treatment Plant Expansion

Harry S. Truman Parkway Annapolis, Maryland
December 20, 2010

Mr. Brian Balchunas
Post Buckley Schuh & Jernigan
12101 Indian Creek Court
Beltsville, MD  20705

Subject: Revised Geotechnical Engineering Report, Broad Creek Water Treatment Plant Expansion, Harry S. Truman Parkway, Annapolis, Maryland (Our 29097)

Dear Mr. Balchunas:

GeoConcepts Engineering, Inc. (GeoConcepts) is pleased to present this revised geotechnical engineering report for the above referenced project. These services have been performed in accordance with our agreement dated August 26, 2008.

1.0 Scope of Services

This geotechnical engineering report presents the results of the field investigation, soil laboratory testing, and engineering analysis of the geotechnical data. This report specifically addresses the following:

- An evaluation of subsurface conditions within the area of the proposed site development, including a seismic site classification per the International Building Code, and metal corrosion and concrete attack potential of the site soils.
- Foundation recommendations for support of the proposed structures and floor slabs on grade.
- Lateral earth pressures for use in design of below grade walls.
- Subdrainage recommendations for handling of groundwater during construction and final design.
- Earthwork recommendations for construction of loadbearing fills, including an assessment of on-site soils to be excavated for re-use as fill.
- Excavation support recommendations, including areas that can be sloped instead of supported.
- Comments regarding the potential of soil liquefaction under the proposed structures.

Services not specifically identified in the contract for this project are not included in the scope of services.
2.0 Site Description and Proposed Construction

The Broad Creek Water Treatment Plant is located at 165 Harry S. Truman Parkway in Annapolis, Maryland. A site vicinity map is presented as Figure 1 at the end of this report. The proposed improvements to the existing treatment plant include the proposed Clarifier ‘C’, the proposed filter and clearwell structure, and the proposed aerator system addition. The slab elevations have been set at approximately EL 65 for the filter and clearwell structure, and EL 76.5 for the clarifier ‘C’ and aerator addition. We understand that maximum column loads will be about 65 kips for the aerator addition.

3.0 Subsurface Conditions

Subsurface conditions were investigated by drilling two test borings in the proposed site development area. Test boring logs and a boring location plan are presented in Appendix A of this report.

3.1 Stratification

The subsurface materials encountered have been stratified for purposes of our discussions herein. These stratum designations do not imply that the materials encountered are continuous across the site. Stratum designations have been established to characterize similar subsurface conditions based on material gradations and parent geology. The subsurface materials encountered in the test borings completed at the site have been assigned to the following strata:

- **Stratum A**
  - Existing Fill
  - generally firm, clayey sand, FILL, with varying amounts of organics and gravel, moist, brown.

- **Stratum B**
  - (Aquia Formation)
  - generally firm, clayey SAND (SC) and POORLY GRADED SAND (SP-SM) with silt, moist, brown.

The two letter designations included in the strata descriptions presented above and on the test boring logs represent the Unified Soil Classification System (USCS) designations for the samples based on visual classifications conducted in the field during the subsurface investigation. Visual classifications were made using the methods described in ASTM D-2488, and may not match classifications determined by laboratory testing per ASTM D-2487.

3.2 Geology

The site is located within the Coastal Plain Physiographic Province of Maryland. The Coastal Plain consists of a seaward thickening wedge of unconsolidated to semi-consolidated sedimentary deposits from the Cretaceous Geologic Period to the Holocene Geologic Epoch. These deposits represent marginal-marine to marine sediments consisting of interbedded sands and clays. The Coastal Plain is bordered to the east by the Atlantic Ocean and to the west by the Piedmont Physiographic Province. The dividing line between the Coastal Plain and the Piedmont is locally referred to as the “Fall Line”. This
name comes from the waterfalls that form as a result of the differential erosion that occurs as streams cross the Piedmont/Coastal Plain contact.

The natural soils assigned to Stratum B are believed to be Coastal Plain sedimentary deposits belonging to the Aquia Formation from the late Paleocene geologic epoch. These soils are believed to be regressive continental shelf deposits associated with an ancient water level of the Atlantic Ocean.

### 3.3 Groundwater

Groundwater level observations were made in the field during drilling and up to five days after the completion of the test borings. Groundwater was encountered at depths of about 39 to 40 feet below the existing ground surface, or about EL 33 to EL 36. Longer-term water level data did not indicate groundwater to the depths the borings caved. Accordingly, the hydrostatic groundwater table should be at least 30 feet below the proposed lower slab levels.

The groundwater observations presented herein are considered to be an indication of the groundwater levels at the dates and times indicated. Accordingly, the groundwater information presented herein should be used with caution. Also, fluctuations in groundwater levels should be expected with seasons of the year, construction activity, changes to surface grades, precipitation, or other similar factors.

### 3.4 Soil Laboratory Test Results

Selected soil samples obtained from the field investigation were tested for moisture-density relations, grain size distribution, Atterberg limits, and natural moisture contents. A summary of soil laboratory test results is presented as Appendix B. The results of natural moisture content tests are presented on the test boring logs in Appendix A.

A sample tested from Stratum A classified as clayey SAND (SC) in accordance with the USCS, with about 32 percent fines passing the U.S. Standard No. 200 sieve. The liquid limit and plasticity index were 32 and 15, respectively. Natural moisture content was 14.8 percent.

Samples tested from Stratum B classified as clayey SAND (SC) and POORLY GRADED SAND (SP-SM) with silt in accordance with the USCS, with about 9 to 40 percent fines passing the U.S. Standard No. 200 sieve. Liquid limits and plasticity indices ranged from non-plastic to 49, and non-plastic to 29, respectively. Natural moisture contents ranged from 9.4 to 19.7 percent. Maximum dry density and optimum moisture content ranged from 113.9 pcf to 115.3 pcf, and 14.5 to 14.7 percent, respectively.

### 3.5 Metal Corrosion/Concrete Attack Test Results

In addition to standard geotechnical soil laboratory testing, two samples were submitted to an analytical laboratory for metal corrosion and concrete attack testing. The testing consisted of analysis for moisture content (ASTM D-2216), pH (SM 9045C), resistivity (ASTM G57), sulfate (AASHTO T290), reduction-oxidation potential (ASTM D-1498 mod.), and chlorides (AASHTO T291). The results of these tests are presented below:
Based on these test results, site soils are considered non-corrosive to ductile iron pipe. Based on published correlations between sulfate concentrations and concrete attack, the above sulfate concentrations are considered to pose a negligible threat of concrete attack.

### 3.6 In-Situ Shear Wave Velocity Test Results

A Refraction Microtremor (ReMi) survey was performed at the site to measure the in-situ shear wave velocities of the subsurface for use in determining the seismic site class in accordance with IBC requirements. The seismic site class definitions for the weighted average of shear wave velocity in the upper 100 feet of the soil profile are presented in the IBC and are summarized in the table below.

<table>
<thead>
<tr>
<th>Site Class</th>
<th>Soil Profile Name</th>
<th>Shear Wave Velocity, Vs (ft/s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Hard rock</td>
<td>Vs &gt; 5,000 ft/s</td>
</tr>
<tr>
<td>B</td>
<td>Rock</td>
<td>2,500 &lt; Vs &lt; 5,000 ft/s</td>
</tr>
<tr>
<td>C</td>
<td>Very dense soil and soft rock</td>
<td>1,200 &lt; Vs &lt; 2,500 ft/s</td>
</tr>
<tr>
<td>D</td>
<td>Stiff soil profile</td>
<td>600 &lt; Vs &lt; 1,200 ft/s</td>
</tr>
<tr>
<td>E</td>
<td>Soft soil profile</td>
<td>Vs &lt; 600 ft/s</td>
</tr>
</tbody>
</table>

The results of the shear wave survey are presented in Appendix A of this report and are summarized in the table below. The approximate locations of the survey lines are shown on Figure 4 in Appendix A of this report.

<table>
<thead>
<tr>
<th>Seismic Line No.</th>
<th>Measured Shear Wave Velocity, Vs (ft/s)</th>
<th>Site Class</th>
</tr>
</thead>
<tbody>
<tr>
<td>L1</td>
<td>1,106</td>
<td>D</td>
</tr>
<tr>
<td>L2</td>
<td>1,040</td>
<td>D</td>
</tr>
<tr>
<td>L3</td>
<td>1,076</td>
<td>D</td>
</tr>
</tbody>
</table>

Based on the results of the in-situ shear wave testing, the site soils have been assigned to a site class D per the International Building Code.

### 4.0 Engineering Analysis

Recommendations regarding foundations, lower floor slabs, lateral earth pressures, subdrainage, earthwork, excavation support, and liquefaction potential are presented herein.
4.1 **Shallow Foundations**

Based on the lower slab elevations for the proposed structures, firm natural soils or new compacted fill should be encountered at normal shallow foundations depths. Shallow foundations founded in these materials are considered suitable for support of the proposed structures, and may be designed with allowable soil bearing pressures as presented in the following table. Recommendations for placement of new compacted fill are presented in Section 4.5 of this report.

<table>
<thead>
<tr>
<th>Structure</th>
<th>Recommended Allowable Bearing Pressure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Filter and Clearwell</td>
<td>2,500 psf</td>
</tr>
<tr>
<td>Aerator System Addition</td>
<td>3,000 psf</td>
</tr>
<tr>
<td>Clarifier 'C'</td>
<td>2,000 psf</td>
</tr>
</tbody>
</table>

The existing fill (i.e. in the vicinity of test boring B-2) will not be suitable for direct support of shallow foundations. Accordingly, we recommend removing all of the existing fill in the structure areas down to natural soils and replacing it with new compacted fill as necessary to reach design subgrades.

Exterior foundation subgrades should be located at least 2.5 feet below final exterior grades for frost considerations. Individual column foundations and continuous wall foundations should be at least 30 inches and 18 inches wide, respectively, for punching shear considerations. A maximum slope of one horizontal to one vertical (1H:1V) should be maintained between the bottom edges of adjacent foundations. Settlement of foundations should not exceed about 1 inch and differential settlement between adjacent foundation elements should not exceed about one-half this amount.

Shallow foundations should be observed and approved prior to placement of concrete, to ascertain that foundations are placed on suitable bearing soils as recommended herein. Foundations should be excavated and concrete placed the same day in order to avoid disturbance from water or weather. Disturbance of foundation subgrades by exposure to water seepage or weather conditions should be avoided. Any existing fill, disturbed, frozen, or soft subgrade soils should be removed prior to placing foundation concrete. It may be desirable to place a 3 to 4-inch thick “mud mat” of lean concrete immediately on the approved foundation subgrades to avoid softening of the exposed subgrade. Forms may be used if necessary, but less subgrade disturbance is anticipated if excavations are made to the required dimensions and concrete placed against the soil. If foundations are formed, the forms should be removed and the excavation backfilled as soon as possible. Water should not be allowed to pond along the outside of foundations for long periods of time.

4.2 **Mat Foundation**

Lower slabs supported by natural soils or new compacted fill are considered feasible at the site. The lower floor slab may be designed based on a modulus of subgrade reaction $K_{01}$ of 125 pounds. Where mat foundation subgrades consist of existing fill (i.e. in the vicinity of test boring B-2), we recommend undercutting the existing fill in its entirety and backfilling with new compacted fill as
necessary to reach design subgrades. Recommendations for placement of new compacted fill are presented in Section 4.5 of this report. All debris and soft soils near the final mat slab subgrade as a result of construction operations should be stripped and removed prior to placement of mat concrete.

Strict quality control should be provided during construction of the mat to ensure that the mat is placed on undisturbed subgrade soils immediately after excavations are complete. The excavation should be performed using equipment that can reach out and cut down to the subgrade without tracking across the subgrade and disturbing the underlying material. A 3 to 4 inch thick concrete work mat should be placed on the freshly excavated subgrade, to allow for installation of reinforcing steel prior to the final mat pour. Excavations should not be performed in inclement weather that causes the excavated subgrade to become disturbed, and excavations should not be left open overnight without placing a concrete work mat on the subgrade. Also, the prepared subgrade must be prevented from freezing if work is performed in the winter months. It is noted that in cases where a concrete work mat has been installed and cold weather conditions exist, provisions should be made to prevent the underlying soil subgrade from freezing and becoming disturbed.

4.3 Lateral Earth Pressures

Below grade walls should be designed to withstand lateral earth pressures. An average equivalent fluid pressure of 60H (psf) should be used for design of basement walls, where H refers to the height of the wall. The design should account for any surcharge loads within a 45 degree slope from the base of the wall. A recommended lateral earth pressure diagram for use in the design of below grade walls is presented as Figure 2 at the end of this report.

Hydrostatic pressures are not included in the lateral earth pressure diagram assuming the use of relatively granular or free draining backfill, and perimeter subdrainage at the base of walls below grade. Recommended subdrainage for below grade walls is presented in Section 4.4 of this report. Recommendations for backfill against walls below grade are presented in Section 4.5 of this report.

4.4 Subdrainage

Based on groundwater observations in the test borings drilled at the site and groundwater mapping published by the USGS, groundwater is expected to be at least 30 feet below proposed lower slab levels. Therefore, temporary construction dewatering should not be necessary for the proposed construction. However, perimeter subdrainage is recommended at the base of below grade walls, as presented on Figure 3 at the end of this report.

4.5 Earthwork

Fill will be required for site grading including backfill against walls below grade. Unsuitable existing fill, soft or loose natural soils, organic material, and rubble should be stripped to approved subgrades as determined by the geotechnical engineer. The actual depth of stripping necessary to provide a suitable base for placement and compaction of earthwork may include topsoil and other soft
surficial layers with or without organic matter. The depth of required stripping should be determined prior to construction by the excavation contractor using test pits, probes, or other means that the contractor wishes to employ, and this determination should be the responsibility of the excavation contractor. All subgrades should be proofrolled with a minimum 10 ton, loaded dump truck or suitable rubber tire construction equipment approved by the geotechnical engineer, prior to the placement of new fill.

The new fill should extend at least 10 feet outside structure lines, as illustrated by Figure 4 at the end of this report. Fill material should be compacted in lifts not exceeding 8 inches loose thickness, to at least 95 percent of the maximum dry density per ASTM D-698. Materials used for compacted fill for support of foundations and floor slabs, and as backfill against walls below grade, should consist of soils classifying SC, SM, SP, SW, GC, GM, GP, or GW per ASTM D-2487, with a liquid limit and plasticity index less than 40 and 15, respectively. It is expected that the majority of soils excavated from Strata A and B will be suitable for re-use as fill based on classification. However, the Stratum A existing fill may not be suitable for re-use as new compacted fill due to deleterious man-made materials in the fill. In addition, moisture conditioning of excavated soils by wetting and mixing may be necessary to obtain proper compaction. Earthwork operations should be planned for early Spring through late Fall, when drier weather conditions can be expected. Individual borrow areas, both from on-site and off-site sources, should be sampled and tested to verify classification of materials prior to their use as fill.

Fill materials should not be placed on frozen or frost-heaved soils, and/or soils that have been recently subjected to precipitation. All frozen or frost-heaved soils should be removed prior to continuation of fill operations. Borrow fill materials should not contain frozen materials at the time of placement.

Compaction equipment that is compatible with the soil type used for fill should be selected. Theoretically, any equipment type can be used as long as the required density is achieved; however, sheepsfoot roller equipment are best suited for fine-grained soils and vibratory smooth drum rollers are best suited for granular soils. Ideally, a smooth drum roller should be used for sealing the surface soils at the end of the day or prior to upcoming rain events. In addition, compaction equipment used adjacent to walls below grade should be selected so as to not impose undesirable surcharge on walls. All areas receiving fill should be graded to facilitate positive drainage of any water associated with precipitation and surface run-off.

After completion of compacted fill operations in building areas, construction of building elements should begin immediately, or the finished subgrade should be protected from exposure to inclement weather conditions. Exposure to precipitation and freeze/thaw cycles will cause the finished subgrade to soften and become excessively disturbed. If development plans require that finished subgrades remain exposed to weather conditions after completion of fill operations, additional fill should be placed above finished grades to protect the newly placed fill. Alternatively, a budget should be established for reworking of the upper 1 to 2 feet of previously placed compacted fill.
4.6 **Liquefaction Potential**

Soil liquefaction is a process by which loose, saturated granular deposits lose a significant amount of their shear strength due to pore water pressure buildup resulting from cyclical loading. Such a reduction/loss of shear strength can result in both settlement and horizontal movement (lateral spreading) of the soil mass. There are several soil characteristics that a soil must have to be prone to liquefaction. In general, loose granular soils present in the uppermost 50 feet of the soil profile that are saturated are most susceptible to liquefaction. In addition, the age and stress history of the soils and the amount and plasticity of soil fines has an effect on the liquefaction potential for a soil. Older deposits have had a greater amount of time to consolidate and are more likely to have been subjected to cyclical loading in the past, which increases a soils resistance to liquefaction.

Based on the results of two test borings and three refraction microtremor (ReMi) survey lines completed at the site, the soil profile consists of firm clayey sand soils with a shear wave velocity (Vs) of about 750 feet per sec (ft/s) in the upper 40 feet. Below about 40 feet, the maximum depth penetrated by the drilling equipment, shear wave velocities increase to about 1,400 ft/s. At about 75 feet depth, shear wave velocities increase to about 1,800 ft/s. The shear wave data suggests that the soil profile beneath the site becomes denser with depth. The soils recovered during drilling to 40 feet depth contained between about 10 and 40 percent fines, with the fines found to be moderately plastic.

The natural soils at the site belong to the Aquia Formation. Aquia Formation soils were deposited in a regressive marine environment about 55 million years ago. Groundwater was encountered at depths between about 39 feet and 40 feet. Aquifer mapping performed by the USGS indicates that groundwater within the Aquia Formation is present at about EL 20 to EL 30, or about 45 to 55 feet below the existing ground surface at the site.

Analyses of the geotechnical and geologic data indicate that the potential for liquefaction at the site is negligible because of the depth to groundwater and the firm nature of the site soils. In addition, the presence of plastic fines and the age of the site soils make them less likely to liquefy during cyclical loading.

5.0 **General Limitations**

Recommendations contained in this report are based upon the data obtained from the relatively limited number of test borings. This report does not reflect conditions that may occur between the points investigated, or between sampling intervals in test borings. The nature and extent of variations between test borings and sampling intervals may not become evident until the course of construction. Therefore, it is essential that on-site observations of subgrade conditions be performed during the construction period to determine if re-evaluation of the recommendations in this report must be made. It is critical to the successful completion of this project that GeoConcepts be retained during construction to observe the implementation of the recommendations provided herein.
This report has been prepared to aid in the evaluation of the site and to assist your office and the design professionals in the design of this project. It is intended for use with regard to the specific project as described herein. Changes in proposed construction, grading plans, structural loads, etc. should be brought to our attention so that we may determine any effect on the recommendations presented herein.

An allowance should be established for additional costs that may be required for foundation and earthwork construction as recommended in this report. Additional costs may be incurred for various reasons including wet fill materials, soft subgrade conditions, unexpected groundwater problems, etc.

This report should be made available to bidders prior to submitting their proposals to supply them with facts relative to the subsurface conditions revealed by our investigation and the results of analyses and studies that have been performed for this project. In addition, this report should be given to the successful contractor and subcontractors for their information only.

We recommend the project specifications contain the following statement: “A geotechnical engineering report has been prepared for this project by GeoConcepts Engineering, Inc. This report is for informational purposes only and should not be considered part of the contract documents. The opinions expressed in this report are those of the geotechnical engineer and represent their interpretation of the subsoil conditions, tests and results of analyses that they performed. Should the data contained in this report not be adequate for the contractor's purposes, the contractor may make their own investigations, tests and analyses prior to bidding.”

This report was prepared in accordance with generally accepted geotechnical engineering practices. No warranties, expressed or implied, are made as to the professional services included in this report.
We appreciate the opportunity to be of service for this project. Please contact the undersigned if you require clarification of any aspect of this report.

Sincerely,
GEOCONCEPTS ENGINEERING, INC.

Amy E. Strobel, CPG
Senior Geologist

Paul E. Burkart, PE
Principal

Figure 1: Site Vicinity Map
Figure 2: Design Earth Pressures for Below Grade Walls
Figure 3: Foundation Subdrainage Design Recommendations
Figure 4: Compacted Structural Fill Diagram

Appendix A: Subsurface Investigation Report
Appendix B: Soil Laboratory Test Report
SURCHARGE WHERE APPLICABLE

HORIZONTAL PRESSURE FROM SURCHARGE
(0.47 X VERTICAL SURCHARGE)

AT-REST EQUIVALENT FLUID PRESSURE = 60H(psf)

NOTES:
1) PRESSURE DIAGRAM SHOWN ASSUMES HORIZONTAL GROUND BEHIND WALL AND FULL DRAINAGE OF HYDROSTATIC PRESSURES.

2) BACKFILL SHOULD CONSIST OF MATERIAL CLASSIFIED AS SC, SM, SP, SW, GC, GM, GP, OR GW PER ASTM D-2487. THE LIQUID LIMIT AND PLASTICITY INDEX OF BACKFILL MATERIAL SHOULD NOT EXCEED 40 AND 15, RESPECTIVELY.
NOTES:

1) BACKFILL SHOULD CONSIST OF MATERIAL CLASSIFIED SM, SP, SW, GM, GP, OR GW PER ASTM D-2487. THE LIQUID LIMIT AND PLASTICITY INDEX OF THE BACKFILL MATERIAL SHOULD NOT EXCEED 40 AND 15, RESPECTIVELY.

2) SUBDRAINAGE PIPING SHOULD BE 4" DIA. SLOTTED CORRUGATED POLYETHYLENE (PE) TUBING ACCORDING TO ASTM F-405 WITH 1/8 INCH SLOT WIDTH. PIPING SHOULD CONNECT TO A SUMP FOR DISPOSAL OR TO A SUITABLE GRAVITY OUTLET.

3) FILTER MATERIAL SHOULD SATISFY REQUIREMENTS FOR AASHTO NO. 7.

4) PERMEABLE GEOTEXTILE FABRIC SHOULD HAVE AN EQUIVALENT OPENING SIZE NOT GREATER THAN THE U.S. STANDARD NO 70 SIEVE.

5) WASHED GRAVEL OR CRUSHED STONE SHOULD SATISFY GRADATION REQUIREMENTS FOR AASHTO NO. 57.
Subsurface Investigation Report

Subsurface Investigation Procedures (1 page)
Identification of Soil (1 page)
Test Boring Notes (1 page)
Test Boring Logs (2 pages)
Shear Wave Test Results (3 pages)
Boring Location Plan, Figure 5 (1 page)
**Subsurface Investigation Procedures**

1. **Test Boring – Hollow Stem Augers**
   The borings are advanced by turning an auger with a center opening of 2-¼ inches. A plug device blocks off the center opening while augers are advanced. Cuttings are brought to the surface by the auger flights. Sampling is performed through the center opening in the hollow stem auger, by standard methods, after removal of the plug. Usually, no water is introduced into the boring using this procedure.

2. **Standard Penetration Tests**
   Standard penetration tests are performed by driving a 2 inch O.D., 1-¾ inch I.D. sampling spoon with a 140-pound hammer falling 30 inches, according to ASTM D-1586. After an initial 6 inches penetration to assure the sampling spoon is in undisturbed material, the number of blows required to drive the sampler an additional 12 inches is generally taken as the N value. In the event 30 or more blows are required to drive the sampling spoon the initial 6 inch interval, the sampling spoon is driven to a total penetration resistance of 100 blows or 18 inches, whichever occurs first. The sampling operation is terminated after a total of 100 hammer blows and the depth of penetration is recorded.

3. **Test Boring Stakeout**
   The test boring stakeout was provided by GeoConcepts personnel using available site plans. Ground surface elevations were estimated from topographic information contained on the site plan provided to us and should be considered approximate. If the risk related to using approximate boring locations and elevations is unacceptable, we recommend an as-drilled survey of boring locations and elevations be completed by a licensed surveyor.
IDENTIFICATION OF SOIL

I. DEFINITION OF SOIL GROUP NAMES

<table>
<thead>
<tr>
<th>Coarse-Grained Soils</th>
<th>ASTM D-2487</th>
<th>Symbol</th>
<th>Group Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>More than 50% retained on No. 200 sieve</td>
<td>Gravels - More than 50% of coarse fraction retained on No. 4 sieve</td>
<td>Clean Gravels</td>
<td>GW</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Less than 5% fines</td>
<td>GP</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Gravels with Fines More than 12% fines</td>
<td>GM</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Clean Sands Less than 5% fines</td>
<td>GC</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Sands with fines More than 12% fines</td>
<td>SW</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Sands - 50% or more of coarse fraction passes No. 4 sieve</td>
<td>SP</td>
</tr>
<tr>
<td>Fine-Grained Soils</td>
<td>Silts and Clays - Liquid Limit less than 50</td>
<td>Inorganic</td>
<td>CL</td>
</tr>
<tr>
<td>50% or more passes the No. 200 sieve</td>
<td></td>
<td>Organic</td>
<td>ML</td>
</tr>
<tr>
<td></td>
<td>Silts and Clays - Liquid Limit 50 or more</td>
<td>Inorganic</td>
<td>OL</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Organic</td>
<td>MH</td>
</tr>
<tr>
<td>Highly Organic Soils</td>
<td>Primarily organic matter, dark in color, and organic odor</td>
<td>PT</td>
<td>PEAT</td>
</tr>
</tbody>
</table>

II. DEFINITION OF MINOR COMPONENT PROPORTIONS

<table>
<thead>
<tr>
<th>Minor Component</th>
<th>Adjective Form</th>
<th>Approximate Percentage of Fraction by Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gravelly, Sandy</td>
<td>With Sand, Gravel, Silt, Clay</td>
<td>30% or more coarse grained</td>
</tr>
<tr>
<td></td>
<td></td>
<td>15% to 29% coarse grained</td>
</tr>
<tr>
<td></td>
<td></td>
<td>5% to 12% fine grained</td>
</tr>
</tbody>
</table>

III. GLOSSARY OF MISCELLANEOUS TERMS

SYMBOLS -
Unified Soil Classification Symbols are shown above as group symbols. Use "A" Line Chart for laboratory identification. Dual symbols are used for borderline classification.

BOULDERS & COBBLES -
Boulders are considered pieces of rock larger than 12 inches, while cobbles range from 3 to 12 inches.

DISINTEGRATED ROCK -
Residual rock material with a standard penetration test (SPT) resistance between 60 blows per foot and refusal.

ROCK -
Rock material with a standard penetration test (SPT) resistance of 100 blows for 2 inches or 50 blows for 0 inches, or less penetration.

DECOMPOSED ROCK -
Residual rock material exhibiting rock-like properties that can be excavated by backhoe equipment. Similar to Disintegrated Rock, but cannot be classified as such because SPT N-Values were not obtained.

ROCK FRAGMENTS -
Angular pieces of rock, distinguished from rounded transported gravel, which have separated from original vein or strata and are present in a soil matrix.

QUARTZ -
A hard silicate mineral often found in residual soils. Only used when describing residual soils.

CEMENTED SAND -
Usually localized rock-like deposits within a soil stratum composed of sand grains cemented by calcium carbonate, iron oxide, or other minerals. Commonly encountered in Coastal Plain sediments, primarily in the Potomac Group sands (Kps).

MICA -
A plate-like phyllosilicate mineral found in many rocks, and in residual or transported soil derived therefrom.

ORGANIC MATERIALS (Excluding Peat) -
Topsoil - Surface soils that support plant life and contain organic matter.
Lignite - Hard, brittle decomposed organic matter with low fixed carbon content (a low grade of coal).

FILL -
Probable Fill -
Soils which contain no visually detected foreign matter but which are suspect with regard to origin.

LAYERS -
COLOR -
MOISTURE CONDITIONS -
1/2 to 12 inch seam of minor soil component.
Two most predominant colors present should be described.
Wet, moist, or dry to indicate visual appearance of specimen.
**Test Boring Notes**

1. Classification of soil is by visual inspection and is in accordance with the Unified Soil Classification System.

2. Estimated groundwater levels are indicated on the logs. These are only estimates from available data and may vary with precipitation, porosity of soil, site topography, etc.

3. Sampling data presents standard penetrations for 6 inch intervals or as indicated with graphic representations adjacent to the sampling data.

4. The logs and related information depict subsurface conditions at the specific locations and at the particular time when drilled. Soil conditions at other locations may differ from conditions occurring at the test locations. Also, the passage of time may result in a change in the subsurface conditions at the test locations.

5. The stratification lines represent the approximate boundary between soil types as determined in the sampling operation. Some variation may be expected vertically between samples taken. The soil profile, groundwater level observations and penetration resistances presented on the logs have been made with reasonable care and accuracy and must be considered only an approximate representation of subsurface conditions to be encountered at the particular location.

6. Disintegrated rock is defined as residual earth material with a penetration resistance between 60 blows per foot and refusal. Spoon refusal at the surface of rock, boulders, or obstructions is defined as a penetration resistance of 50 blows for 0 inches penetration. Auger refusal is taken as the depth at which further penetration of the auger is not possible without risking significant damage to the drilling equipment.
<table>
<thead>
<tr>
<th>STRATUM</th>
<th>MATERIAL DESCRIPTION</th>
<th>ELEV. (ft)</th>
<th>DEPTH (ft)</th>
<th>MIC (%</th>
<th>SPT BLOW COUNTS</th>
<th>RECOVERY (%)</th>
<th>STANDARD PENETRATION TEST RESISTANCE (BLOWS/FOOT)</th>
</tr>
</thead>
<tbody>
<tr>
<td>74.7</td>
<td>Topsoil = 4 inches clayey SAND (SC), moist, brown</td>
<td>29097</td>
<td>74.7</td>
<td>10.9</td>
<td>2+4+5+6</td>
<td>20</td>
<td>20</td>
</tr>
<tr>
<td>68.5</td>
<td>POORLY GRADED SAND (SP), with silt, moist, brown</td>
<td></td>
<td>61.5</td>
<td>9.9</td>
<td>4+6+7</td>
<td>18</td>
<td>18</td>
</tr>
<tr>
<td>61.5</td>
<td>clayey SAND (SC), moist, brown</td>
<td>61.5</td>
<td>61.5</td>
<td>16.5</td>
<td>4+6+6</td>
<td>18</td>
<td>18</td>
</tr>
<tr>
<td></td>
<td>Bottom of Boring at 40.0 ft</td>
<td>36.0</td>
<td>40.0</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

GROUND WATER LEVELS:
- Encountered: 39.0 ft ELEV. 36.0
- Upon Completion: Dry Caved: 14.0 ft ELEV. 61.0
  4/14/2010 Dry Caved: 12.0 ft ELEV. 63.0

REMARKS:

THE STRATIFICATION LINES REPRESENT APPROXIMATE BOUNDARIES. THE TRANSITION MAY BE GRADUAL.
# Borehole Log

**Project:** Broad Creek Water Treatment Plant  
**Logged By:** A. Hogan  
**Boring Number:** B-2  
**Location:** Harry S. Truman Parkway, Annapolis, MD  
**Owner/Client:** PBS&J  
**Drilling Contractor:** Connelly and Associates, Inc.  
**Date Started:** 4/9/10  
**Date Completed:** 4/9/10

<table>
<thead>
<tr>
<th>Depth (ft)</th>
<th>Stratum</th>
<th>Material Description</th>
<th>MC (%)</th>
<th>SPT Blow Counts</th>
<th>Recovery (ft)</th>
</tr>
</thead>
<tbody>
<tr>
<td>72.7</td>
<td>A</td>
<td>Topsoil = 4 inches</td>
<td></td>
<td>2+5+5+7</td>
<td>22</td>
</tr>
<tr>
<td></td>
<td></td>
<td>clayey sand fill, with organics and gravel, moist, brown</td>
<td>14.8</td>
<td>3+5+5</td>
<td>18</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>3+6+7</td>
<td>18</td>
</tr>
<tr>
<td>64.5</td>
<td>B</td>
<td>clayey sand (SC), moist, brown</td>
<td>10.3</td>
<td>5+7+7</td>
<td>18</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>2+2+3</td>
<td>18</td>
</tr>
<tr>
<td>33.0</td>
<td></td>
<td></td>
<td></td>
<td>5+6+8</td>
<td>18</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>6+9+7</td>
<td>18</td>
</tr>
<tr>
<td>40.0</td>
<td></td>
<td></td>
<td></td>
<td>4+6+6</td>
<td>18</td>
</tr>
<tr>
<td>40.0</td>
<td>Bottom of Boring at 40.0 ft</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Ground Water Levels:**  
- Encountered: 40.0 ft ELEV. 33.0
- Upon Completion:  
  - Dry CAVED: 19.7 ft ELEV. 53.3
  - 4/14/2010 Dry CAVED: 28.5 ft ELEV. 44.5

**Remarks:**
- The stratification lines represent approximate boundaries. The transition may be gradual.
Broad Creek Water Treatment Plant, 29097, L1 : Vs Model

Vs100' = 1106 ft/s

Shear-Wave Velocity, ft/s
Broad Creek Water Treatment Plant, 29097, L3: Vs Model

Shear-Wave Velocity, ft/s

Vs100' = 1076 ft/s
Soil Laboratory Test Report

Summary of Soil Laboratory Test Results (1 page)
Gradation Curves (6 pages)
Moisture Density Relation Curves (2 pages)
# Summary of Soil Laboratory Test Results

**Project:** Broad Creek Water Treatment Plant  
**Contract No.:** 29097

<table>
<thead>
<tr>
<th>Boring No.</th>
<th>Depth (ft.)</th>
<th>Sample Type</th>
<th>Stratum</th>
<th>Description of Soil Specimen</th>
<th>Sieve Results</th>
<th>Atterberg Limits</th>
<th>Natural Moisture Content (%)</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>B-2</td>
<td>2.5'-4.0'</td>
<td>Jar</td>
<td>A</td>
<td>clayey sand FILL</td>
<td>10.6</td>
<td>31.7</td>
<td>32 17 15</td>
<td>14.8</td>
</tr>
</tbody>
</table>
| B-1        | 2.0'-7.0'   | Bag         | B       | clayey SAND (SC)              | 0.3           | 32.7            | 32 19 13                  | 10.9    | Max. Dry Density=115.3 lbs/ft³  
Optimum Moisture=14.7% |
| B-1        | 8.5'-10.0'  | Jar         | B       | POORLY GRADED SAND (SP-SM) with silt | 0.0           | 9.2             | NP NP NP                  | 9.4     |
| B-1        | 13.5'-15.0' | Jar         | B       | clayey SAND (SC)              | 0.0           | 22.2            | 41 21 20                  | 16.5    |
| B-2        | 7.0'-13.0'  | Bag         | B       | clayey SAND (SC)              | 0.5           | 39.7            | 34 18 16                  | 10.3    | Max. Dry Density=113.9 lbs/ft³  
Optimum Moisture=14.5% |
| B-2        | 18.5'-20.0' | Jar         | B       | clayey SAND (SC)              | 0.0           | 26.9            | 49 21 28                  | 19.7    |

**Notes:**
1. Soil tests are in accordance with applicable ASTM standards.
2. Soil classification symbols are in accordance with Unified Soil Classification System.
3. Visual identification of samples is in accordance with ASTM D-2488.
4. Key to abbreviations: LL= Liquid Limit; PL= Plastic Limit; PI= Plasticity Index; NP= Nonplastic; N/T = Not Tested
GRAIN SIZE ANALYSIS

Project No. 29097  Project Name  Broad Creek WTP
Test Boring No. B-1  Depth (Feet)  2.0-7.0
Lab Order No. 2282-3  Date  4/22/2010

<table>
<thead>
<tr>
<th>SIEVE</th>
<th>% Passing</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 ½ &quot;</td>
<td>100</td>
</tr>
<tr>
<td>3/4&quot;</td>
<td>100</td>
</tr>
<tr>
<td>3/8&quot;</td>
<td>100</td>
</tr>
<tr>
<td>#4</td>
<td>100</td>
</tr>
<tr>
<td>#10</td>
<td>99</td>
</tr>
<tr>
<td>#20</td>
<td>98</td>
</tr>
<tr>
<td>#40</td>
<td>89</td>
</tr>
<tr>
<td>#60</td>
<td>62</td>
</tr>
<tr>
<td>#100</td>
<td>40</td>
</tr>
<tr>
<td>#200</td>
<td>33</td>
</tr>
<tr>
<td>Pan</td>
<td>--</td>
</tr>
</tbody>
</table>

USCS Group Symbol  SC
USCS Group Name     CLAYEY SAND
Cu                   ---
Cc                   ---
LL                   32
PI                   13
Gravel               0.3
Sand                 67.0
Fines                32.7
AASHTO Classification A-2-6

Test Method: ASTM D 422
Soil Classification by ASTM D2487 and AASHTO M 145

Tested by: ___________________________  Reviewed by: ___________________________
**GRAIN SIZE ANALYSIS**

<table>
<thead>
<tr>
<th>Project No.</th>
<th>29097</th>
<th>Project Name</th>
<th>Broad Creek WTP</th>
</tr>
</thead>
<tbody>
<tr>
<td>Test Boring No.</td>
<td>B-1</td>
<td>Depth (Feet)</td>
<td>8.5-10.0</td>
</tr>
<tr>
<td>Lab Order No.</td>
<td>2282-1</td>
<td>Date</td>
<td>4/22/2010</td>
</tr>
</tbody>
</table>

---

**Grain Size Diameter (mm)**

**USCS Group Symbol**
- Cu
- Cc
- LL
- PI
- Gravel
- Sand
- Fines

**USCS Group Name**
- POORLY GRADED SAND with silt

**SP-SM**
- 4.0
- 1.6
- NP
- NP
- 0.0
- 90.8
- 9.2

**AASHTO Classification**
- A-2-4

- Tested by: ________________________
- Reviewed by: ____________________

Test Method: ASTM D 422
Soil Classification by ASTM D2487 and AASHTO M 145
## GRAIN SIZE ANALYSIS

<table>
<thead>
<tr>
<th>Project No.</th>
<th>29097</th>
<th>Project Name</th>
<th>Broad Creek WTP</th>
</tr>
</thead>
<tbody>
<tr>
<td>Test Boring No.</td>
<td>B-1</td>
<td>Depth (Feet)</td>
<td>13.5-15.0</td>
</tr>
<tr>
<td>Lab Order No.</td>
<td>2282-2</td>
<td>Date</td>
<td>4/22/2010</td>
</tr>
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![Grain Size Diameter (mm) Graph]

<table>
<thead>
<tr>
<th>SIEVE</th>
<th>% Passing</th>
</tr>
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<tbody>
<tr>
<td>1 ½&quot;</td>
<td>100</td>
</tr>
<tr>
<td>3/4&quot;</td>
<td>100</td>
</tr>
<tr>
<td>3/8&quot;</td>
<td>100</td>
</tr>
<tr>
<td>#4</td>
<td>100</td>
</tr>
<tr>
<td>#10</td>
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<tr>
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<tr>
<td>#40</td>
<td>85</td>
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<tr>
<td>#60</td>
<td>50</td>
</tr>
<tr>
<td>#100</td>
<td>29</td>
</tr>
<tr>
<td>#200</td>
<td>22</td>
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<tr>
<td>Pan</td>
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<table>
<thead>
<tr>
<th>USCS Group Symbol</th>
<th>SC</th>
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<tbody>
<tr>
<td>USCS Group Name</td>
<td>CLAYEY SAND</td>
</tr>
<tr>
<td>Cu</td>
<td>---</td>
</tr>
<tr>
<td>Cc</td>
<td>---</td>
</tr>
<tr>
<td>LL</td>
<td>41</td>
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<tr>
<td>PI</td>
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<tr>
<td>Gravel</td>
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<td>Sand</td>
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<td>Fines</td>
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**AASHTO Classification**: A-2-7

Test Method: ASTM D 422
Soil Classification by ASTM D2487 and AASHTO M 145

Tested by: ____________________  Reviewed by: ____________________
**GRAIN SIZE ANALYSIS**

<table>
<thead>
<tr>
<th>Project No.</th>
<th>29097</th>
<th>Project Name</th>
<th>Broad Creek WTP</th>
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<td>B-2</td>
<td>Depth (Feet)</td>
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<td>Lab Order No.</td>
<td>2282-4</td>
<td>Date</td>
<td>4/22/2010</td>
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<table>
<thead>
<tr>
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<tbody>
<tr>
<td>1 ½&quot;</td>
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<td>3/4&quot;</td>
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<td>#200</td>
<td>32</td>
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<tr>
<td>Pan</td>
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**USCS Group Symbol**: CLAYEY SAND

**USCS Group Name**: CLAYEY SAND

<table>
<thead>
<tr>
<th>SC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cu</td>
</tr>
<tr>
<td>Cc</td>
</tr>
<tr>
<td>LL</td>
</tr>
<tr>
<td>PI</td>
</tr>
<tr>
<td>Gravel</td>
</tr>
<tr>
<td>Sand</td>
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<tr>
<td>Fines</td>
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**AASHTO Classification**: A-2-6

Test Method: ASTM D 422

Soil Classification by ASTM D2487 and AASHTO M 145

Tested by: _______________  Reviewed by: R. Drew Thomas
GRAIN SIZE ANALYSIS

<table>
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<tbody>
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<td>Test Boring No.</td>
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<td>Depth (Feet)</td>
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<td>Lab Order No.</td>
<td>2282-6</td>
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- **SC**
  - **USCS Group Symbol**: Cu
  - **USCS Group Name**: CLAYEY SAND
  - **Cu**: ---
  - **Cc**: ---
  - **LL**: 34
  - **PI**: 16
  - **Gravel**: 0.5
  - **Sand**: 59.7
  - **Fines**: 39.7

**AASHTO Classification**: A-6

Test Method: ASTM D 422

Soil Classification by ASTM D2487 and AASHTO M 145

Tested by:________________________

Reviewed by: ______________________
# Grain Size Analysis

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## Grain Size Diameter (mm)

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<td>3/4&quot;</td>
<td>100</td>
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<td>#60</td>
<td>71</td>
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<tr>
<td>#100</td>
<td>27</td>
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<td>#200</td>
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<table>
<thead>
<tr>
<th>USCS Group Symbol</th>
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<tbody>
<tr>
<td>USCS Group Name</td>
<td>CLAYEY SAND</td>
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<tr>
<td>Cu</td>
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</tr>
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<td>Cc</td>
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<td>LL</td>
<td>49</td>
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<tr>
<td>PI</td>
<td>28</td>
</tr>
<tr>
<td>Gravel</td>
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<tr>
<td>Sand</td>
<td>73.1</td>
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<tr>
<td>Fines</td>
<td>26.9</td>
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AASHTO Classification: A-2-7

Test Method: ASTM D422
Soil Classification by ASTM D2487 and AASHTO M 145

Tested by: ______________________
Reviewed by: ____________________
MOISTURE-DENSITY RELATIONSHIP

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<tbody>
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<td>2282-3</td>
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<td>4/22/2010</td>
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![Graph showing moisture-density relationship](image)

**TEST RESULTS**

<table>
<thead>
<tr>
<th>Material</th>
<th>Classification</th>
<th>Nat. Moist. (%)</th>
<th>Sp. G. (Assumed)</th>
<th>LL</th>
<th>PI</th>
<th>% &gt; #4</th>
<th>% &lt; #200</th>
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</thead>
<tbody>
<tr>
<td>CLAYEY SAND</td>
<td>USCS SC AASHTO</td>
<td>10.9</td>
<td>2.65</td>
<td>32</td>
<td>13</td>
<td>0.3</td>
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ASTM D 698

Tested by ___________  Reviewed by R. Drew Thomas
MOISTURE-DENSITY RELATIONSHIP

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<th>Project No.</th>
<th>Project Name</th>
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<th>Lab Order No.</th>
<th>Date</th>
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<td>B-2</td>
<td>7.0-13.0</td>
<td>2282-6</td>
<td>4/22/2010</td>
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</table>

![Graph showing the moisture-density relationship](image)

**TEST RESULTS**

<table>
<thead>
<tr>
<th></th>
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<th>After Correc.</th>
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</thead>
<tbody>
<tr>
<td>Maximum Dry Density (pcf)</td>
<td>113.9</td>
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</tr>
<tr>
<td>Optimum Moisture Content (%)</td>
<td>14.5</td>
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</table>

<table>
<thead>
<tr>
<th>Material</th>
<th>Classification</th>
<th>Nat. Moist. (%)</th>
<th>Sp. G. (Assumed)</th>
<th>LL</th>
<th>PI</th>
<th>% &gt; #4</th>
<th>% &lt; #200</th>
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</thead>
<tbody>
<tr>
<td>CLAYEY SAND</td>
<td>USCS SC</td>
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<td>2.6</td>
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<td>16</td>
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<td>AASHTO A-6</td>
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</tbody>
</table>

ASTM D 698

Tested by [Signature]
Reviewed by [Signature]
EQUIPMENT WARRANTY AND CERTIFICATION FORM

Project Name: Broad Creek II WTP Expansion
Owner Contract No. W804001

THE UNDERSIGNED HEREBY ATTESTS THAT HE HAS EXAMINED ALL THE REFERENCED PROJECT DRAWINGS AND SPECIFICATIONS AND HEREBY WARRANTS AND CERTIFIES THAT THE EQUIPMENT, COMPONENT, OR SYSTEM HE PROPOSES TO FURNISH AND DELIVER MEETS OR EXCEEDS CONTRACT SPECIFICATIONS, IS SUITABLE FOR ITS INTENDED PURPOSE AND INSTALLATION, AND WILL PROVIDE SATISFACTORY PERFORMANCE AT THE DESIGN CRITERIA SPECIFIED. THIS WARRANTY SHALL BE IN ADDITION TO AND NOT IN LIEU OF ALL OTHER WARRANTIES, EXPRESS OR IMPLIED.

EQUIPMENT: ____________________________________________________________

MANUFACTURER: _______________________________________________________

Address: _________________________________
_____________________________________

By: _______________________________________________ _____________
   (Type Name and Title)                                        (SEAL)
   _______________________________________ /s/ _________ _________
   (Signature)      (Date)

Equipment Warranty and Certification must be signed by a Principal Person (President, Vice-President, etc.) of the equipment manufacturer. In the event the manufacturer is not the Supplier, then a Principal Person of the Supplier must also sign this form.

SUPPLIER:  ________________________________________ ______________

Address: __________________________________________ ____________
_____________________________________________________

By: _______________________________________________ _____________
   (Type Name and Title)                                   (SEAL)
   _______________________________________ /s/ _________ _________
   (Signature)      (Date)